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AERIAL NAVIGATION.*

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THERE are now dawnings of two possible solutions of the problem of aerial navigation; a problem which has impassioned men for perhaps 4,000 or 5,000 years. Navigable balloons have recently been developed to what is believed to be nearly the limit of their efficiency, and after three intelligent but unfortunate attempts by others, a successful dynamic flying machine seems to have been produced by the Messrs. Wright.

It is therefore interesting to review the present status of the question, the prospects of its solution and the probable uses of the hoped-for air-ships.

Balloons.

As to balloons, we may pass over the early gropings and failures to make them navigable. It was recognized very soon that the spherical balloon was the sport of the wind, that it was necessary to elongate it in order to evade the resistance of the air, and that, inasmuch as aerial currents are much more rapid than aqueous currents, it was necessary to obtain considerable speeds in order to have a useful air-ship. This means that there must be great driving power, and that this power shall weigh as little as possible; for in any case the balloon itself with its adjuncts and passengers will absorb the greater part of its lifting power.

Giffard was the first to apply in 1852 an artificial motor to an elongated balloon. This motor consisted in a steam-engine of three horse power, which weighed with its appurtenances 462 pounds, and

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Giffard obtained only 6.71 miles per hour, although his balloon was 144 feet long and 39 feet in diameter, or about the size of a tramp steamer.

Dupuy de Lome in 1872 went up with a balloon 118 feet long and 49 feet in diameter, but, having a wholesome dread of the contiguity of fire and inflammable gas, he employed man power (weighing about 2,000 pounds to the horse power) to drive his screws, and he obtained less speed than Giffard. The accidents to Wölfert and to DeBradsky have since shown the soundness of his fears.

Next came Tissandier in 1884, who employed an electric motor of 1½ horse power, weighing some 616 pounds, with which he attained 7.82 miles per hour.

Meanwhile the French war department took up the problem. It availed itself of the labors of the previous experimenters and made careful and costly investigations of the best modes of construction, of the best shapes to cleave the air and of the weight and efficiency of motors. This culminated in 1885 when Messrs. Renard and Krebs, of the Aeronautical Section, brought out the war balloon 'La France' which attained about 14 miles an hour (or half the speed of a trotting horse) and returned to its shed five times out of the seven occasions on which it was publicly taken out.

This air ship was 165 feet long, 27½ feet in diameter and was provided with an electric motor of 9 horse power, weighing with its apurtenances some 1,174 pounds. The longitudinal section was parabolic, somewhat like a cigar rolled to a sharp point at both ends, the largest cross-section being one fourth of the distance from the front, and it was driven, blunt end foremost, by a screw attached at the front of the car. No better shape and arrangement have yet been devised and subsequent experimenters who have wandered away therefrom have achieved inferior results, so far as the coefficient of resistance is concerned.

In 1893 the French War Department built the 'General Meusnier,' named after an aeronautical officer of extraordinary merit of the first French Republic. This war balloon is said to be 230 feet long, 30 feet in diameter, 120,000 cubic feet in capacity and to have been originally provided with a gasoline motor of 45 horse power. It is said by all the writers on the subject that it was *never taken out.* Possibly the French were waiting for a war which fortunately never came; but, be this as it may, it is probable that with the reduction which has since taken place in gasoline motors this balloon could carry an engine of some 70 horse power, and attain a speed of about 30 miles an hour, which is greater than that of transatlantic steamers.

Some unsuccessful experiments were carried on in Germany in 1897. First by Dr. Wölfert, whose balloon was set on fire by his gasoline motor and exploded in the air, killing both himself and his engi-

neer, and later by Schwarz, whose aluminum balloon proved unmanageable and was smashed in landing. The most ambitious attempt, however, was that of Count Zeppelin, who built in 1900 a monster air-ship 420 feet long and 39 feet in diameter. It was a cylinder with paraboloid ends, but the shape was inferior and almost all the lifting power was frittered away on a internal frame of aluminum, so that the gasoline motor could be of only 32 horse power, and the speed attained has variously been stated at 8 to 18 miles per hour. Nevertheless the design of Count Zeppelin contained many excellent features, and a movement is now on foot in Germany to enable him to try again, through means of a popular subscription. The mere size, if he builds again as large, is a great element of success, for as the cubic contents and lift increase as the cube of the dimensions, while the weights increase in a far smaller ratio, a balloon of this great size ought to be able to lift a very powerful motor, and to attain a speed of 30 or more miles per hour. He has shown that the size is not beyond the possibility of control.

Meanwhile gasoline motors had been increasing in efficiency and diminishing in weight. The French war department gave no sign and it was reserved for a Brazilian, Mr. Santos Dumont, to show to the Parisians what could be accomplished by equipping an air-ship with a gasoline motor. The history of his triumphs is so present to all minds that it need only be alluded to, but it may be interesting to give some details of the sizes and arrangements of his various balloons. His first idea seems to have been that, in order to make it manageable, a balloon should be made as small as possible, and that it was practicable to disencumber it of many adjuncts hitherto considered indispensable. Neglecting to study carefully what had been found out by his predecessors, he had to learn by experience, and he built five balloons, all navigables, before he produced in 1901 his No 6, with which he won the Deutsch Prize, by sailing 3½ miles and return in half an hour. This balloon was 108 feet long, 20 feet in diameter and was provided with a gasoline motor of 16 horse power which might be driven up to 18 or 20 horse power. While the speed over the ground was 14 miles an hour, retarded as it was by a light wind, the speed through the air was about 19 miles an hour, a small but marked advance over any previous performance; but the result would have been still better if the shape had been that of Colonel Renard's balloon.

Since then Mr. Santos Dumont has built four new navigable balloons. His No. 7, with which he expects to compete at St. Louis in 1904, is 160 feet long and 23 feet in diameter and is to be provided with a motor of 60 horse power. His No. 8, which was sold to parties in New York last year. His No. 9, which is his visiting balloon, being only 50 feet long and 18 feet in diameter and provided with a 3 horse power motor. Its speed is only 10 miles an hour, but it is handy to

ride around to breakfast or afternoon teas. He is now finishing his No. 10, the omnibus, which is 157 feet long and 28 feet in diameter, with a motor of 46 horse power. Fares are to be charged for by the pound of passenger when it comes out next spring.

Emulators of Santos Dumont there have been that have come to grief. Mr. Roze built in 1901 a catamaran consisting of two twin balloons, which, although 148 feet long, failed to raise their own weight serviceably. Mr. Severo built in 1902 a navigable balloon which was so injudiciously constructed that the car broke away in the air, and the inventor was killed as well as his engineer. Later in the same year DeBradsky built a navigable balloon equipped with a gasoline motor located so near the vent for the gas that the latter took fire, exploded the balloon, and the inventor and his engineer were killed, thus for the second time verifying the fears of the experts who discountenanced this combination.

Some meritorious projects have been published but not yet carried out. Among these may be mentioned that of Mr. Yon, now deceased, and that of Mr. Louis Godard. The latter project was for a balloon 180 feet long and 36 feet in diameter, with two steam motors of 50 horse power each. It was expected to attain a speed of 30 miles per hour.

One navigable balloon which was built this year, that of the Lebaudy brothers, has achieved a great success. It is 185 feet long, 32 feet in diameter, and is equipped with a gasoline motor of 40 horse power. It has beaten the speed of Santos Dumont, having on many occasions, it is said, attained 24 miles an hour.

There is also a navigable balloon being built in Paris by Mr. Tatin for Mr. Deutsch, the donor of the famous prize. This is 183 feet long, 27 feet in diameter and is equipped with a gasoline motor of 60 horse power.

Besides these there are said to be a number of navigable balloons either being built or proposed in France. They are those of the Marquis de Dion, of Pillet & Robert, of Girardot, of Boisset and of Bourgoin, but there is no telling how many of them will materialize.

These are all French balloons, while there are in England the balloon of Mr. Spencer, 93 feet by 24 feet with nominally 24 horse power; of Mr. Beedle, 93 feet by 24 feet with 12 horse power, and that of Dr. Barton, now in construction, with dimensions of 170 feet in length, 40 feet in diameter, and equipped with a number of aeroplanes and three gasoline motors of 50 horse power each. It is a question whether the weight of the aeroplanes will leave sufficient margin to lift 150 horse power.

The ultimate practicable size for balloons is not yet known, but the mathematics of the subject are now tolerably well understood. The larger the balloon the more speed it can attain, and it is possible

to design it so that the results shall not be disappointing. Those inventors who expect to attain 70 to 100 miles an hour by some happy combination do not know what they are talking about.

It is interesting to speculate which of the above-mentioned navigable balloons would, if competing, stand a chance of winning the $100,000 prize which has been offered by the St. Louis Exposition of 1904. So far as can now be discerned, the only vessels which are likely to develop the required minimum speed of 20 miles an hour over the ground, which speed really requires about 25 miles an hour through the air as there will almost invariably be some wind, will be the Santos Dumont No. 7, the Lebaudy and the Deutsch air-ships, all of them French. The English vessels of Spencer and of Beedle are too small to lift sufficient power to drive them at 25 miles an hour. The balloon of Dr. Barton might gain this speed if it were not 40 feet in diameter, besides being loaded down with aeroplanes, and it remains to be seen what will be the effect of this combination. The American air-ships all seem to be too small to lift enough power to give them the required speed save the Stanley air-ship, 228 feet by 56 feet in diameter, begun in San Francisco. Should this be completed in time, and should the weights be kept approximately near those stated in the circulars, it might have a chance to obtain 25 miles an hour, but it would need more than three times the 50 horse power contemplated in order to do so, and the weight of the aluminum shell and framing would probably absorb much of the lifting power.

Flying Machines.

If the aeronautical contest at St. Louis were scheduled to take place a few years later, thus giving time to consummate recent success, it is not improbable that the main prize would be carried off by a flying machine. This yet lacks the safe flotation in the air which appertains to balloons, but it promises to be eventually very much faster.

The writer found, somewhat to his surprise, when on a visit to Paris last April, that a decided reaction has set in among the French against balloons. It seemed to be realized that the limit of speed had been nearly reached for the present, and that but small utility was to be expected from navigable balloons. They must be large, costly and require expensive housing, while they are slow and frail and carry very small loads. As commercial carriers they are not to be thought of, but they may be useful in war and in exploration.

Hence the French are turning their thoughts towards aviation and propose to repeat some of the experiments with gliding machines which have taken place in America. Even Colonel Renard, the celebrated pioneer of the modern navigable balloon, is now said to have become a convert to aviation and to say that the time has come to try the

system of combined aeroplanes and lifting screws for flying apparatus.

A good deal of experimenting has been done with power-driven flying models. The more recent types have been actuated by twisted rubber threads, by compressed air and by steam, and the most notable experiments in order of date are those of Penaud, Tatin, Hargrave, Phillips, Langley and Tatin and Richet. The data for these (except the first) will be found by searchers in such matters in the London *Times* edition of the 'Encyclopædia Britannica,' in the article on aeronautics. The most successful experiment was that of Professor Langley, who obtained in 1896 three flights of about three fourths of a mile each with steam-driven models, the apparatus alighting safely each time and being in condition to be flown again.

The one great fact which appears from all these various model experiments is that it requires a relatively enormous power to obtain support on the air. Omitting the cases in which the power was probably overestimated, the weights sustained were but 30 to 55 pounds to the horse power expended, thus comparing most unfavorably with the weights transported by land or by water; for a locomotive can haul about 4,000 pounds to the horse power upon a level track, and a steamer can propel a displacement of 4,000 pounds per horse power on the water at a speed of 14 miles an hour.

But models are, to a certain extent, misleading. They seldom fly twice alike and they do not unfold the vicissitudes of their flight. Moreover, the design for a small model is sometimes quite unsuited for a large machine, just as the design for a bridge of ten feet opening is unsuited for a span of one hundred feet.

After experimenting with models three celebrated inventors have passed on to full-sized machines, to carry a man. They are Maxim, Ader and Langley, and all three have been unsuccessful, simply because their apparatus did not possess the required stability. They might have flown had the required equilibrium and strength been duly provided.

At a cost of about $100,000, Sir Hiram Maxim built and tested in 1894 an enormous flying machine, to carry three men. It consisted in a combination of superposed aeroplanes, portions of which bagged under air pressure, and it was driven by two screws 17 feet 10 inches in diameter, actuated by a steam engine of 363 horse power with steam at 275 pounds pressure. The supporting surface was about 4,000 square feet, and the weight 8,000 pounds. The machine ran on a track of 8-feet gauge, and was prevented from unduly rising by a track above it of 30-feet gauge. At a speed of 36 miles per hour all the weight was sustained by the air, and on the last test the lifting effect became so great that the rear axle trees were doubled up and finally one of the front wheels tore up about 100 feet of the upper track; when steam was shut off and the machine dropped to the ground

and was broken. Its short flight disclosed that its stability was imperfect and Sir Hiram Maxim has not yet undertaken the construction of the improved machine which he is understood to have had under contemplation.

Having already built in 1872 and 1891 two full-sized flying machines with doubtful results, Mr. Ader, a French electrical inventor, built in 1897 a third machine at a cost of about $100,000 furnished by the French War Department. It was like a great bird, with 270 feet supporting surface and 1,100 pounds weight, being driven by a pair of screws actuated by a steam engine of 40 horse power which weighed about 7 pounds per horse power. Upon being tested under the supervision of the French army officers, the equilibrium was found so defective that further advance of funds was refused. The amount lifted per horse power was 27 pounds.

The data for the full-sized flying machine of Professor Langley, tested October 7 and December 8, 1903, have not yet been published. From newspaper photographs it appears to be an amplification of the models which flew successfully in 1896, and this, necessarily, would make it very frail. The failures, however, seem to have been caused by the launching gear and do not prove that this machine is worthless. Like the failures of Maxim and of Ader, it does indicate that a better design must be sought for, and that the first requisites are that the machine shall be stable in the air, shall be quite under the control of its operator, and that he, paradoxical as it may appear, shall have acquired thorough experience in managing it before he attempts to fly with it.

This was the kind of practical efficiency acquired by the Wright Brothers, whose flying machine was successfully tested on the seventeenth of December. For three years they experimented with gliding machines, as will be described farther on, and it was only after they had obtained thorough command of their movements in the air that they ventured to add a motor. How they accomplished this must be reserved for them to explain, as they are not yet ready to make known the construction of their machine nor its mode of operation. Too much praise can not be awarded to these gentlemen. Being accomplished mechanics, they designed and built the apparatus, applying thereto a new and effective mode of control of their own. They learned its use at considerable personal risk of accident. They planned and built the motor, having found none in the market deemed suitable. They evolved a novel and superior form of propeller; and all this was done with their own hands, without financial help from anybody.

Meantime it is interesting to trace the evolution which has led to this result and the successive steps which have been taken by others.

It is not enough to design and build an adequate flying machine; one must know how to use it. There is a bit of tuition which most

of us have seen, that of the parent birds teaching their young to fly, which demonstrates this proposition. Even with thousands of years' evolution and heredity, with adequate flying organs, the birdlings need instruction and experience.

Safety is the all-important requisite. It is indispensable to have a flying machine which shall be stable in the air, and to learn to master its management. Nothing but practise, practise, practise, will gain the latter, and upon this the school of Lilienthal and his followers is founded.

Otto Lilienthal was a German engineer of great originality and talent, who after making very valuable researches, assisted by his brother, published a book in 1889, 'Der Vogelflug als Grundlage der Fliegekunst,' which it is very desirable to have translated and published for the benefit of English investigators. Then, putting his theories to the test of practise, he built from 1891 to 1896 a number of aeroplane machines with which he diligently trained himself in gliding flight, using gravity for a motive power, by starting from hillsides. He grew exceedingly expert, and made, it is said, more than 2,000 flights, until one rueful day (August 9, 1896) he was upset and killed by a wind gust, probably in consequence of having allowed his apparatus to get out of order.

He was followed by Mr. Pilcher, an English marine engineer, who slightly improved the apparatus, but who, after making many hundred glides, was also upset and killed in October, 1899, through structural weakness of his machine.

The basis for the equilibrium of an apparatus gliding upon the air being that the center of gravity shall be on the same vertical line as the center of air pressure, both Lilienthal and Pilcher reestablished this condition by moving their bodily weight to the same extent that the center of pressure varied through the turmoils of the wind. The writer ventured to think this method erroneous, and proposed to reverse it by causing the surfaces themselves to alter their position, so as to bring the center of pressure back vertically over the center of gravity. He began experimentally with man-carrying gliding machines in June, 1896, and has since built six machines of five different types, with three of which several thousand glides have been effected without any accidents. The first was a Lilienthal machine, in order to test the known before passing to the unknown, and this was discarded some six weeks before Lilienthal's sad accident.

With three of the other machines favorable results were obtained. The best were with the 'two-surface' machine, equipped with an elastic rudder attachment designed by Mr. Herring, and this was described and figured in the 'Aeronautical Annual' for 1897.

Three years later Messrs. Wilbur and Orville Wright took up the problem afresh and have worked independently. These gentlemen

have placed the rudder in front, where it proves more effective than in the rear, and have placed the operator horizontally on the machine, thus diminishing by four fifths the resistance of the man's body from that which obtained with their predecessors. In 1900, 1901, 1902 and 1903 they made thousands of glides without accidents and even succeeded in hovering in the air for a minute and more at a time. They had obtained almost complete mastery over their apparatus before they ventured to add the motor and propeller. This, in the judgment of the present writer, is the only course of training by which others may hope to accomplish success. It is a mistake to undertake too much at once and to design and build a full-sized flying machine *ab initio,* for the motor and propeller introduce complications which had best be avoided until in the vicissitudes of the winds bird-craft has been learned with gravity as a motive power.

Now that an initial success has been achieved with a flying machine, we can discern some of the uses of such apparatus, and also some of its limitations. It doubtless will require some time and a good deal of experimenting, not devoid of danger, to develop the machine to practical utility. Its first application will probably be military. We can conceive how useful it might be in surveying a field of battle, or in patrolling mountains and jungles over which ordinary means of conveyance are difficult. In reaching otherwise inaccessible places such as cliffs, in conveying messages, perhaps in carrying life lines to wrecked vessels, the flying machine may prove preferable to existing methods, and it may even carry mails in special cases, but the useful loads carried will be very small. The machines will eventually be fast, they will be used in sport, but they are not to be thought of as commercial carriers. To say nothing of the danger, the sizes must remain small and the passengers few, because the weight will, for the same design, increase as the cube of the dimensions, while the supporting surfaces will only increase as the square. It is true that when higher speeds become safe it will require fewer square feet of surface to carry a man, and that dimensions will actually decrease, but this will not be enough to carry much greater extraneous loads, such as a store of explosives or big guns to shoot them. The power required will always be great, say something like one horse power to every hundred pounds of weight, and hence fuel can not be carried for long single journeys. The north pole and the interior of Sahara may preserve their secrets a while longer.

Upon the whole, navigable balloons and flying machines will constitute a great mechanical triumph for man, but they will not materially upset existing conditions as has sometimes been predicted. Their design and performance will doubtless be improved from time to time, and they will probably develop new uses of their own which have not yet been thought of.

THE METRIC SYSTEM: SHALL IT BE COMPULSORY?

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NO tribe of savages has ever been found that did not present some evidence of the existence of individual property among them. By force of character and personal prowess the chief acquires possessions of increasing variety. Where compulsion can not be directly applied resort is had to exchange, and this at once develops the need for measurement of values. Local convenience suggests conventional standards for the measurement of quantity, and custom tends to fix such standards. When a number of tribes have become aggregated into an embryonic nation, the different standards are soon found to need revision. From a group of temporary standards some fall into disuse and the most convenient are retained. The readiest standard of length is some part of the human body, such as the forearm or hand. The cubit is thus one of the most ancient of units. The foot, the pace, the palm, the digit, the inch as the length of the last bone of the thumb, the yard as arm length from mouth to finger tip, all of these are units of unknown antiquity, and accurate enough for the common needs of many who are moderately civilized to-day.

The unit of length is the primary unit to which finally all others are referred. To derive from it units of surface and volume would appear most natural, and it seems but a short step farther to derive a unit of mass from the unit volume of some selected kind of matter, such as water or earth. But it is safe to say that such a process of derivation was unknown until within the last few centuries or even less. For the comparison of masses scales were early developed, and with the advance of civilization linear units derived from human bodies of variable size gave place to metallic standards prepared and kept by some central authority. From the buried city of Pompeii have been taken steelyards carrying inscriptions which showed that they had been 'proved' by comparison with the standards kept in the Temple of Jupiter at Rome.

In England the standard of length during the last eight or nine centuries has been the yard, traditionally derived from the length of the arm of King Henry I. about the year 1101. A rod or bar of this length was kept in London, and copies of it, of various grades of crudeness, received the royal stamp which made them legal measures. One third of this length was called a foot, although about one fifth

longer than the average masculine foot. Both in England and on the continent legislation relating to standards of measurement was exceedingly lax, and in every important town the local magistrate developed or maintained his own municipal system of weights and measures. A comparison of nomenclature in different languages shows that the foot has been the generally selected unit of length; and the Latin word *pondus,* meaning a weight, has been used with variations, such as *pound* and *pfund,* to express the popular unit of weight. With such unlimited local freedom, such imperfect means of communication, and such scanty diffusion of education, it is not remarkable that even so recently as a century ago the number of different units of length and weight, called by similar names, should be so great as almost to defy numeration. Even as late as 1850, in a 'Dictionary of Weights and Measures' at that time known, 5,227 of these were recorded. There were 135 varieties of foot; 60 of the inch; 29 of the pint; 53 of the mile, and 235 of the pound. The names foot and pound, or their equivalents in widely different languages, have been applied to magnitudes, nominally constant but practically variable, during the last 2,000 years. The Olympic foot, in use among the ancient Greeks, was traditionally derived from the foot of Hercules. To eradicate the popular devotion to these standards, variable as they may be, can not be accomplished in a generation. The range of variation among different values of the foot has been from 8.75 inches to 23.22 inches, or over 165 per cent.

Standards of weight and measure are thus the products of the people. The fundamental condition to be fulfilled is that a standard shall be definite and invariable. The function of legislation is not to create standards, but to adopt and protect them. This necessity was appreciated certainly as far back as the time of the Romans, but the recognition of it implies a degree of civilization that was not shared with them by the peoples they had nominally conquered. In England there is no record of such legislation prior to the thirteenth century. By statute of King Henry III., A. D. 1266, the combined standard of money, weight and capacity was defined by the statement that 'an English penny, called a sterling, round and without any clipping, shall weigh thirty-two wheat corns in the midst of the ear; and twenty pence do make an ounce, and twelve ounces one pound, and eight pounds do make a gallon of wine, and eight gallons of wine do make a London bushel, which is the eighth part of a quarter.' This pound, thus equal to the weight of 7,680 wheat grains, was known as the sterling or easterling pound, and had long been in use among the nations of eastern Europe. It is supposed to have been brought to England in the time of the Crusades. The troy pound and the avoirdupois pound additionally came into use, their origin and time of introduction being un-

known. The pound sterling continued to be the legal standard until 1496, when it was superseded by the pound troy.

King Edward II., in 1324, provided by statute that the inch should have the length of 'three barley corns, round and dry, laid end to end.' Of these inches 12 were to make one foot, and 36 of them one yard. The length of a barley corn must have been known to be quite as variable as that of the royal arm. Yard sticks were indeed kept in the royal exchequer, but care in preservation seems to have been quite as unknown as methods of precision in construction.

By the middle of the eighteenth century the influence of such men as Sir Isaac Newton had produced a very perceptible effect on English civilization. The Royal Society of London, chartered in 1662 and including all the scientific leaders of the kingdom, recognized the chaotic condition of English weights and measures; and in 1742 a standard yard was constructed by one of its members, George Graham, who determined the ratio of its length to that of a pendulum beating seconds. This pendulum length he found to be 39.14 inches. It is most unfortunate that this length was not adopted as that of the yard, even if its value was not known with the utmost precision. Had the inch been defined as one fortieth part of this length, and the foot as ten inches, not only would the foot have been made to accord with the actual length of the average masculine foot, but a decimal division of it would have been established. The binary division of the yard would have been maintained, and its value would have been so nearly the same as that of the meter, afterward adopted as an international unit of length, that identification of the British and metric units would have been easy. But the people were not seeking ideals. Graham's yard was constructed for the Royal Society and there is no evidence of its adoption by the government. The official standard until 1824 was a brass rod made in 1570. It had been broken and mended so badly that the joint was described to be 'nearly as loose as that of a pair of tongs.' A copy of Graham's yard was made by Mr. Bird for a parliamentary committee in 1758 and another in 1760, but not adopted until 1824. This was known as the 'imperial standard yard.' At the same time a brass weight which had been in the custody of the House of Commons since 1758 was adopted as the 'imperial standard troy pound.' But the avoirdupois pound was also officially recognized, the difference between the two being that the troy pound was defined to be 5,760 grains and the avoirdupois pound 7,000 grains. The 'imperial standard gallon' was made the official standard of capacity for both liquid and dry measure. Under certain standard conditions of measurement this was defined to be the volume of 10 avoirdupois pounds of water, or 227.274 cubic inches. The wine gallon of 231 cubic inches had previously been the standard of capacity since 1706.

The subdivisions and multiples of these standards were such as to necessitate much confusion. The troy pound was divided into 12 ounces of 480 grains each, and the avoirdupois pound into 16 ounces of 437.5 grains each. The troy pound is less than the avoirdupois pound and the troy ounce greater than the avoirdupois ounce. A distinction has to be made additionally between dry ounces and fluid ounces. Various bushels and tons of widely different values continue in use. Although the original English standards were destroyed by fire in 1834, they were subsequently reproduced with reasonable accuracy. They are now the standards of the British empire with a total population of nearly 400,000,000 people, among whom a multitude of other unstandardized units of weight and measure are in current use.

The American colonies naturally employed such coins, weights and measures as were used in the mother country, and in no two of them were the 'systems' alike. A decimal system of currency proposed by Thomas Jefferson was introduced in 1792 and has continued in satisfactory use ever since. In taking this rational step the American republic set an example which has subsequently been followed by a large majority of the civilized nations of two hemispheres. Different monetary units are employed, such as the dollar, the franc and the florin, but the great advantage of decimal multiplication and division is almost universally recognized. The constitution authorizes congress to fix all standards of weight and measure for the entire country, and Mr. Jefferson urged the adoption of a decimal system for these as well as for our coinage. But this plan was not followed, and now after the lapse of a century American weights and measures are still in a state of confusion; some of them reasonably definite, others unintelligible except by the use of qualifying circumlocutions, and none of them connected by very simple numerical relations. A copy of the English yard was tentatively adopted in 1814 as the American linear standard. A copy of the troy pound was in 1828 made the standard of weight for the mint, and in 1830 the avoirdupois pound, deduced from the troy pound, was legalized as the standard of weight for ordinary commercial transactions. At the same time the wine gallon of 231 cubic inches was adopted as the standard of capacity for liquids, and the Winchester bushel of 2,150.42 cubic inches for solids. It will be observed, therefore, that the British gallon exceeds the American gallon by 20 per cent. The British bushel contains 2,218.192 cubic inches, and thus exceeds the American bushel by a little over 3 per cent. If we speak of a gallon or bushel, the meaning is thus not clear without further specification. But without reference to English units, or units that are obsolete or infrequently employed, we have in general use in America two different pounds, two different ounces, two different quarts, two different tons, two different miles, and a complex relation between linear, square

and cubic measures, and between volume and weight. This diversity is not so confusing as it might be, because the foot and inch are perfectly definite in value, and a pound is generally understood to mean an avoirdupois pound.

In 1790, the same year in which Jefferson presented to American legislators his decimal system of coinage, weights and measures, Prince Talleyrand in France distributed among the members of the Constituent Assembly at Paris a proposal to found a new system of weights and measures upon some natural and invariable standard, with the hope that it might become a world system and thus displace the multitude of complexities which constituted a serious barrier to commerce. The cooperation of Great Britain was particularly desired, and a special invitation was conveyed to the British parliament to send commissioners from the Royal Society for the purpose of conference with a similar commission from the French Academy of Sciences. The British government withheld even the courtesy of an acknowledgment. Spain, Italy, the Netherlands, Denmark and Switzerland were represented in the conference. The result is now too well known for special recital. The metric system of weights and measures was born amid the throes of the French Revolution. With the reign of terror it had nothing in common. It was a model of simplicity and consistency, but it had two important elements of weakness. The first of these is found in the fact that there had been no popular demand for it. The second is that it was based on the false assumption that an absolute and invariable standard can be found in nature. Each of these elements is worth consideration.

The function of legislation in connection with science is to utilize science for the general welfare only so far as the people are prepared to accept improvement. In a community where ignorance prevails even sanitary science can not be enforced for the saving of human life from pestilence, unless military despotism is substituted for local self-government until the causes of pestilence are eradicated. Water as clear and sparkling as the freshest dew-drop may contain in solution tasteless poison that spreads typhoid fever or cholera among the ill-informed skeptics who are unwilling to be taxed for their own protection. The French people knew nothing of the branch of applied science now called metrology. They felt no evils as the outcome of a multitude of unrelated weights and measures, incomprehensible to most of the world. The new decimal system was easy to brand as the fiction of doctrinaires, just as the taxpayers in a fever-stricken community denounce and resist the officers of the law who close an infected spring of water. The logical outcome of the French revolution was the military despotism of Napoleon, and by this means the metric system was forced upon an unwilling people. The generation on whom

the imposition was laid never really adopted it. The succeeding generations have been gradually losing the memory of the old weights and measures, and the inherent merits of the new system are such that relapse to the old barbarism is now impossible, whatever may be the modifications gradually imposed in practise upon a system of metrology which owed its existence to special creation rather than evolution. The case is quite comparable with the new era of sanitation in Cuba. Yellow fever has been almost wholly stamped out. The superiority of the new conditions is now recognized, and the Cubans will probably never return voluntarily to the régime of filth which fixed a scourge upon Havana for two centuries.

Prior to the French revolution various propositions and experimental attempts had been made to secure an absolute standard of length. In England Graham had tried to establish the length of a seconds pendulum as a standard, but without permanent success. In France several years were devoted by Delambre and Méchain to the determination of the length of an arc of the meridian between Dunkirk and Barcelona. The quadrant as computed from this survey was 10,000,000 times the length of the adopted standard, the meter. The outcome was no more absolute than any other product of human skilled labor. The opponents of the metric system have been fond of calling attention to the mistake in computed value of the meter. The labors of Bessel, Schubert and Clarke have established the existence of an error of about one part in 7,000. This means that the meter is shorter than it ought to be by an average hair's breadth; but this small error is quite sufficient to prove that the actual meter is an arbitrary standard. The fact is admitted as readily by the advocates as it is proclaimed by the opponents of the system. The most enthusiastic of these opponents have been the members of a small clique, led by the late Piazzi Smyth of Edinburgh, who claimed to have discovered in the pyramids of Egypt convincing evidence that the British inch is the only absolute unit, a definite fraction of the earth's polar diameter. Such conclusions are quite harmless; equally unassailable and incapable of proof. The real merit of the metric system is found in its definiteness and simplicity, and not at all in any approximate relation between its fundamental unit and the earth's polar circumference, or any other terrestrial dimension, whatever may have been the intention of its originators.

The metric system was adopted in France in 1795 and made obligatory in 1801. The change was too sudden for the people and compromise was found necessary. The full enforcement of the law dates from 1840, and the system has since become gradually and quite thoroughly established. France is a republic, and the law would long ago have been repealed if good reason for such action existed. At the close of the Franco-German war an important step in the unification of the

new German empire was the substitution of the metric system for the many widely different local systems of metrology. The German people are now accustomed to it, and there is no more danger of its abandonment in Germany than in France. A list of forty-three countries could be given, the governments of which have adopted the metric system. This includes the greater part of continental Europe and of the American continent south of the United States. It has been legalized, but not made obligatory, in the United States and Great Britain. In Denmark it has not yet been fully adopted, but is largely used in trade, in coinage and in the railway system. In Austria, it has been established since 1876; in Norway and Sweden since 1889; in Turkey since 1891. In all cases it is reported to have given great satisfaction to the commercial classes, the chief obstacle being the ignorance and consequent opposition of the peasantry. From a carefully prepared list it is found that the population of the countries that have adopted the metric system is now a trifle less than 500,000,000. In 1863 it was about 140,000,000. The number has been more than trebled in forty years. In Russia a decree looking to its general adoption has been prepared by the minister of finance, approved by the administrative council, and is now awaiting the signature of the Czar. Should this be given, the system receives an addition of over 100,000,000 people to be put in training.

In the United States the first general legislation on the subject of weights and measures was an act of congress in 1866, by which the use of the metric system was made lawful, but not obligatory. No recognition of the theoretic superiority of any system is ever sufficient to induce the people to discard the system to which they are accustomed, however cumbrous this may be. The law of 1866 might be defined as merely legislative politeness. In 1875 an international conference was agreed upon by the most important nations of the world with a view to the promotion of some common system of metrology. The result was the establishment of the international bureau of weights and measures at Paris, maintained jointly by the participating governments. The first object to be attained was the preparation of a new international standard meter and a new international standard kilogram, certified copies of which were to be furnished to each government. The preparation of these was the work of a number of years. The copies sent to the United States were officially adopted by Congress, April 5, 1893, as the American national standards. The yard is hence legally defined as a definite fraction of a meter, and the pound as a definite fraction of a kilogram. This was an important step, but was regarded by many as of no practical importance, the use of the British standards being still protected by law.

The next step forward in this country was the adoption, July 12, 1894, of eight units for the measurement of electrical magnitudes.

Electricity as a quantitative science is founded on the metric system. The congress of electricians at Chicago in 1893 fixed the electrical units for the entire world, and these have been legalized by all the governments represented in that congress. In one branch of industry, of great and growing importance, the civilized world is thus united in the use of a common system of measurement. It would probably be hard to find an electrical engineer in England or America who is not in favor of the universal adoption of the metric system.

During the last dozen years there has been a growing popular demand among the commercial classes throughout the English speaking world for the general adoption of the metric system. This demand is not based on any theoretic ground, such as its simplicity and consistency, but on the commercial need of international uniformity. It would have no existence if all civilized nations used the British system. New markets can not be secured if customers are unable to understand the mode of measuring what is bought or must present their specifications in terms that are unsuited to the machinery employed in manufacture. Moreover, those who are already accustomed to a simpler system can not be expected to adopt in its place what is to them complex, unintelligible, indefinite and radically incapable of being made simple. Whatever may be the claims made by those who are accustomed to a bad system of metrology, or who have property that would be made valueless by its abolition, there is scarcely any conceivable prospect of the universal adoption of the British system. In the race for commercial supremacy there is little respect shown for theory, sentiment, old habits or corporate vested interests. The demands of trade must finally be met, even if vested interests should be strong enough to retard satisfactory legislation. The demand for international uniformity will continue to grow. The choice of the whole world has to be made between two systems of metrology, and only two, the British and the metric. All others have been practically eliminated from such a contest. If England and America should completely dominate the trade of the rest of the world the British system will be established; if not, it is doomed. Its total destruction will not be witnessed by any now living, but uniformity of weights and measures for the civilized world is as reasonably to be expected as was the establishment of Jefferson's monetary system throughout the union of American states.

In 1895 a select committee of the house of commons, after carefully considering commercial demands in England, urged upon the government that the metric system be at once legalized and that it be made compulsory by act of parliament after a lapse of two years. A deputation from thirty-nine chambers of commerce, including those of London, Edinburgh, Liverpool, Birmingham and Belfast, urged upon Mr. Balfour the importance of carrying out the recommendations of the

committee. A large number of other associations representing many thousands of influential business men joined in the demand. Mr. Balfour admitted the merits of the metric system, but was unwilling that it be made compulsory in the near future, because he feared the effect on the small retail dealers and those who buy their goods from such dealers. He did not consider the British public yet ready for so important a change. The result was the legalizing of the metric system in Great Britain, but the defeat of the effort to make it compulsory. A great number of commercial associations, large and small, were added to the first list, and in not a single case did any body of wholesale or retail traders oppose the compulsory adoption of the metric weights and measures.

In 1896 a bill was introduced into congress at Washington for the compulsory use of the metric system in all departments of the government after July 1, 1898, and the adoption of it as the only legal system of weights and measures in the United States after January 1, 1901. This bill was reported favorably by the Committee on Coinage, Weights and Measures, but it was found necessary to delay action upon it. A second trial was made in 1902, and the committee secured the views of prominent representatives of a large number of different professions, trades and manufacturing interests. Of the many written communications, about nine tenths advocated the adoption of the metric system. Of the witnesses who appeared in person before the committee, which included 29 men of recognized standing in their respective callings, 23 were in favor and 6 of them opposed to the bill. Of the 6 opponents 4 represented large manufacturing interests involving the application of mechanical engineering, and 2 were connected with the revenue system of the government. The chief ground of opposition was the expense and inconvenience involved in making the change. Vested interests thus constitute by far the greatest obstacle next to conservatism.

Much could be written in this connection about the many considerations to be weighed by a congressional committee before reaching a final conclusion on a subject of such grave importance. The volume of testimony to which reference has just been made is a remarkably strong presentation of them. Any one who is enough interested to examine it can obtain a copy, gratuitously, by writing to the chairman of the Committee on Coinage, Weights and Measures at Washington.

Hon. J. F. Shafroth, of Colorado, has recently introduced a bill providing that after January 1, 1905, the metric system shall be made compulsory in all departments of the government in the transaction of business requiring the use of weight and measurement, except in completing the survey of the public lands, and that after January 1, 1906,

it shall be the legal standard of weights and measures of the United States.

Should Mr. Shafroth's bill become a law, it is practically certain that a similar act will be passed by the British parliament soon afterward. Experience in Germany, Switzerland, Austria and other European countries within the last thirty years affords the assurance that, while temporary inconvenience may be expected, the transition will be soon accomplished in all important commercial centers; that persons of middle age and advanced years who have had no previous familiarity with the metric system will continue to use that to which they are accustomed; that the younger generation will everywhere appropriate and appreciate it; and that the agricultural population will be the last to become adapted to the change. Concerted opposition to the metric system by many whose capital would suffer depreciation by change is to be expected. The powerful influence of conservatism will be hard to overcome, however strong may be the arguments of those having commercial interests with Europe and South America. The passage of the metric bill may be again delayed. But the United States has become an exporting country and this necessitates two important changes. One is the removal of unnecessary tariff barriers to foreign trade. The other is the adoption of a system of weights and measures that is equally suited to domestic and foreign trade. Those who have been opposed to the recent American policy of forcible annexation of foreign countries have the partial compensation of knowing that it gives a strong impulse to the unification of weights and measures for the entire world. There may be honest difference of opinion among the advocates of the metric system regarding the advisability of assigning so early a date as 1906 for the legal establishment of this system in our country. Probably all of them will agree that 1905 is not too early a date for the exclusion of the old system and adoption of the new in the different departments of the government. The people will thus be induced to learn the metric system practically and compare its simplicity with the complexity of the system to which they have been accustomed. The opposition to it hitherto has come chiefly from those who have no practical acquaintance with it. They are quite excusable for thinking best to 'let well enough alone,' just as the majority of Englishmen would object to substituting our simple American system of decimal currency for their cumbrous system of farthings, pence, shillings, pounds, crowns and guineas. It is well to remember, moreover, that existing conditions in England and America are quite different from those under which Bismarck introduced the metric system into the newly formed German empire. From the Atlantic to the Pacific, from Mexico to the Arctic circle, there is but a single system of weights and measures, which has some few good features with its many bad ones, and which is satis-

factory to most of those who use it. Change in our system of metrology is not needed for political unification. Any legal enactment imposing a sudden change will be apt to arouse enough popular opposition to ensure its repeal before the people have had a fair chance to give an impartial test to the new system. A probation period of ten years in the government departments might perhaps be better than one year; or possibly it might be wiser at present to avoid specifying the length of any probation period. It would be better for the demand to come from the people at the end of thirty years than for a repeal of the law to be forced after it has been in operation only a short time.

Much has been said about the superiority of a binary to a decimal system. It is admitted that the decimal system is better for purposes of computation, but alleged that in the ordinary practical affairs of life people divide into halves and quarters more readily than into tenths. There can be no objection to the simultaneous application of both methods, so far as convenience may suggest. A binary system does not lend itself to decimal notation, while a decimal system does admit of limited, but amply sufficient, binary subdivision. This has been abundantly shown in the use of American money. Half-dollars and quarter-dollars, as divisions, are entirely satisfactory to all advocates of a decimal system. Our fathers coined eighth-dollars and sixteenth-dollars also, but nobody seemed to want them. Half-meters and quarter-meters as linear divisions are quite as good as half-dollars and quarter-dollars. Our idea of a quarter of a dollar is no less definite if it be called twenty-five cents. In like manner, no one can object to calling twenty-five centimeters either a quarter of a meter or a metric foot, agreeing in length with the human foot. That decimal subdivision is quite as natural as binary subdivision is shown by the universal American tendency to express profits and losses as percentages. If there is any real superiority in binary subdivision all dividends should be expressed in thirty-seconds, or sixty-fourths, or hundred-and-twenty-eighths.

It has been urged that a duodecimal system is better than either a binary or a decimal system. This may be granted, but its introduction would involve practical difficulties much greater than any connected with the general adoption of the metric system, including the abolition of the British system. Its consideration has no more practical importance than a proposition to substitute Volapuk for the English language.

The late Sir Joseph Whitworth expressed the opinion that the adoption of the metric system would be easy if its advocates would only lengthen the meter from 39.37 to 40 inches. This would make the inch rather than the meter our unit of length. Such a change would on many accounts be exceedingly desirable. But its consideration could be only the result of compromise in an international conference

for this purpose. It would require the majority of the nations of the civilized world to change their standard, with all the expense that this implies, for the sake of saving expense to English and American mechanical engineers and capitalists. For the sake of international uniformity such a conference might well be undertaken, although with the assurance that the continental engineers and capitalists would not regard the subject from our standpoint.

Objection has often been made to the nomenclature of the metric system, which is thought to be too diffuse, too high sounding and scholastic to appeal to the masses. Such names as hectare and kilometer are unwelcome to the farmer, who is well satisfied with his acres and miles. There is no good reason to prevent any needed modification in nomenclature so long as the fundamental units and the decimal relation between them are preserved. In our decimal currency the eagles, dimes and mills are for the most part forgotten, while dollars and cents are enough for most purposes. No great inconvenience has resulted from the use of the word 'nickel' for a five-cent piece, or the alleged 'pennies' and Californian 'bits' in the nomenclature of small change. Those who are habituated to the use of the metric system rarely ever speak of decimeters or dekameters, or decigrams or myriagrams. The fathers could not provide for an indefinite future. Elasticity is necessary, and new subordinate units are certainly allowable as long as they serve any useful purpose.

In conclusion, those who advocate the introduction of the metric system will need to be patient and considerate. Those who oppose it must look to the future as well as the present. The well-worn query, 'What has posterity done for me?' is good enough for the local politician but unworthy of the statesman.

THE CONSERVATION OF ENERGY IN THOSE OF ADVANCING YEARS. II.

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Developmental Processes in Ageing Tissues; Physiology of Decadence. Senile Involution.

THE brevity of this communication does not warrant a discussion of senility from the standpoint of the physician, but rather a presentation of such facts to the person who is growing old as may prove helpful and suggestive in postponing the more serious results of advancing years. It is, however, important to glance at the manner and processes by which the inevitable end is reached. The clinical picture of approaching death is divided by Tessier into those structural degenerations involving, first, the heart and blood vessels; second, the lungs; third, the kidneys; fourth, the digestive organs, and fifth, the brain. First of the heart, which is now recognized to be the organ which plays the chief part in the ending of life. Before we knew much about the subject it was natural to infer that the heart was chiefly at fault and the common phrase was often used of death by 'heart failure,' one which we now know to be scientifically correct but aforetime vaguely employed. Then discoveries were made that the arteries in the aged were nearly always diseased, and medical thinkers went so far as to assert that all instances of death in old age resulted from the hardening of the arteries. It is true that this is an accompanying phenomenon in most instances, and perhaps in all, but it is recognized to be not the most potent factor in a certain large proportion.

What is to be said here is not meant for a guide to the aged individual by which he may be encouraged to form independent judgments for himself, but rather to act as items of useful information, through which he can better interpret the statements and appreciate the importance of following the directions of his physician.

The heart of a healthy old person has become fatigued in its structure through a decadence of its nerve supply. The pulse is rather quicker than during middle life; it is more or less irregular and becomes increasingly so. In a healthy heart there is, however, a regular irregularity; a normal sequence of alterations in the rhythm and force which is only significant when studied by the trained physician. The phenomenon which is one of the most constant and inevitable, as the effects of age

begin to make themselves felt, is shortness of breath on exertion. This has to do more with faults in the action of the circulation and the vaso-motor nerves than in the lungs. The old man finds himself distressed in his breathing while undergoing a degree of exertion which aforetime would produce no noticeable effects. The heart muscle is old, relaxed and softened and contracts imperfectly and readily shows exhaustion. This need not produce alarm, but if the condition rapidly increases it may be significant of some important change and should be referred to the medical adviser. In fact, it can not be repeated too often that the more constantly the aged person remains under observation of a wise physician, the more safely can it be promised that he will live happily and long. There is a symptom which is most terrifying and frequently occurs in the aged, and that is a sudden agonizing chest pain, during which the sufferer, unless he be of unusual mental equipoise, feels that he shall instantly die. This may come on suddenly without previous warning and requires the best medical advice, but it almost always passes and may recur many times and is capable of much relief. It may be a symptom of chronic myocardial degeneration.

The lungs also, in most instances, share in the process of death. The changes which occur in the aged lung are degenerative and need have nothing to do with any previously disordered processes in them. Again it may happen that certain changes common in old age take place and prove to be most distressing; the chief of these are asthma, chronic pneumonia and bronchitis. Pneumonia in the aged is a very serious affection, and it is stated that the largest number of deaths in old people are caused, or accompanied by, acute broncho-pneumonia.

The digestive organs sometimes give away while the rest of the organism remains in fairly good condition. Sir William Thomson has written most charmingly upon the digestive disorders of elderly folk, and it would be well for every old person to read his suggestive essays. Unless care is observed in regulating the diet (and the chief point here is rather a reduction in the amount than particularizing as to the items of food taken), distressing phenomena will constantly arise. Fortunately this is easily avoided, although not so readily cured. Sir William Thomson makes the assertion that the disappearance of the teeth is a plain indication of the return to a second childhood, and therefore the food should be of such a character as may not require the assistance of the teeth in mastication. He advises most wisely, although his recommendation can not be taken literally, that the teeth be not replaced by artificial ones, for thereby is a peril lest more food be taken than the organism can dispose of. The fact that the various organs concerned in the elaboration of food share very early in the degenerative changes of age makes it clear that the character of the food taken should be so simple in kind that no great strain would be

placed upon these atrophied organs. The gastric juice is secreted in less quantity, so of the pancreatic, the biliary and the intestinal juices. The lessened quantity of bile makes for constipation and the formation of gall-stones and impairs absorption, and assimilation is thus interfered with. The kidneys, the chief source of elimination of a most elaborate series of poisons, become enfeebled in their action and hence should not be overtaxed by either the quantity or the quality of the work they are called upon to perform. Finally the brain may be the part which gives way most prominently, and then we may find hemorrhages into its structure, a softening begins, and alteration in mentality which point the way to more remote and serious changes.

The physiology of old age may be described briefly as a progressive diminution in all the functional activities. There is in the life of every normal individual a constant and proportional relationship between the development of parts and tissues and the natural progress toward dissolution. The function which is in most immediate relationship to the reparative power of the cells is the one which will be first affected, so soon as old age begins. The four particular acts of nutrition may be succinctly described as: first, contact of the cell with the nutritive elements; second, the phenomena by which sustenance is drawn from this material, namely, assimilation; third, the changes through which the assimilated products pass, namely, dissimilation; and fourth, the phenomena of the ejectment of the non-assimilated substances. In senescence the first change to be noted in these essential steps in nutrition is to be seen in assimilation. The reparative power of the cells is lessened and the elements of repair tend to be furnished in smaller quantities and soon pass beyond the power of maintaining cellular integrity. Next, there is a diminishing cell resistance leading to atrophy and xerosis. Xerosis (Tessier) is the normal hardening of the tissues in contradistinction to the abnormal sclerosis. With diminution in the power of assimilation there will appear modifications in the normal processes of dissimilation. The difficulties which the cell finds in securing the necessary pabulum tends toward inertia in the phenomena of metabolism. Next the products of incomplete oxidation accumulate, are made difficult to get rid of; they are more damaging to the integrity of the structure of the organ, and the tissues undergoing normal senescence are in constant peril of suffering disease changes. It is the presence of these toxins which places the physiologic processes of senility close to the line of pathology with incomplete oxidation; they tend to accumulate, to infiltrate and to work harm. Chemical changes are less active then, and more poisons form than can be thrown off; gout, rheumatism and their simulants arise. The standards for comparison in the phenomena of waste and repair are not to be formulated. The physician can not know, in the light of present knowledge, just

when the equilibrium is lost and when the subject under observation has passed the point where senilization has gone through several changes, and proceeds rapidly, and can not be checked.

Life will flow on with normal energy so long as the noble elements, the more highly differentiated cells, are in excess both in processes and activity. The noble elements are those cells which take upon themselves the preponderating role in accomplishing the function of an organ, in contradistinction to those which play but a secondary part as forming the mechanical support of the organ. Since these can not be replaced in due proportion, function will be interfered with and senescence will begin. Connective tissue now tends to fill all gaps and gradually to invade the tissues, and scleroses will arise, placing obstacles in the way of functional discharge; this constitutes disease. "Inasmuch as the individual is merely an aggregation of special organs adapted to a common existence, the increasing deterioration of these functional activities leads toward gradual deterioration of the individual himself, who will gently fade away out of existence" (Tessier).

The progress of atrophic changes is not regular, either in the general system or in the special organ. All the elements of the mass do not live to the same age. The constituent elements undergo a perpetual restoration, the older disappearing and being replaced by others which have been long maintained in a state of less differentiation, hence of less specialization. As the completed elements disappear the younger ones are matured, hence the compensation is established between atrophy and repair. This movement of partial renovation in tissues is a picture in little of life, the birth of each element, its functional life, senility and death. The explanation of why irregularity should occur in the nutritive activities in the tissues of each organism, and equally in the whole of some organisms, causing individual and constitutional variations, is not so clear. Chemical processes, presumably similar to the small modifications in the cellular arrangements, and the forces that work, must be recognized. In time we may—indeed we must—know what these dynamic features are; then we shall have reached the first step in controlling these variations from a sound working basis. It is certain that these dynamic modifications can not progress indefinitely without producing tangible modifications and alterations in molecular activities; this constitutes disease. Atrophy is an anatomical phase of senility, whose irregular distribution is explained by the inequality of cellular existence, and this is again dependent upon the initial impulse of contraction and upon varying states in the medium, and this by the introduction into the tissues of matters foreign to its normal structure. When this occurs it is degeneration. The study of pathologic changes, by which most of the observations have been

made upon the conditions governing senile processes, induces a tendency to start from wrong premises. It is important that these researches should be strongly modified by a comparison between normal and physiologic changes, otherwise right conclusions are obscured. This practical point must never be lost sight of by observers and clinicians in the study of the individual and his ailments. In the study of the processes of the individual the ailments are too frequently the only conditions considered and the normal changes overlooked.

Clinicians recognize what they call diatheses. A diathesis is a tendency toward disease, and many of these can be recognized in their incipience and differentiated in such manner that preventive measures can be employed and earlier changes limited and improved. Disease is the domain of pathology, the study of abnormal conditions induced by changes outside the realm of individual processes. The diathesis gives evidence of a lessened coefficient of resistance, a lowering in noble activities and exhaustion of the powers of repair. This is probably because the power of attraction is not the same in each person and is of variable intensity. Protoplasm has not the same proportions in its composition, hence variations arise in the phases of its evolution. Assuming then the variability in chemic structure, and hence a variable power of attraction in protoplasm, hence, also in the coefficient of resistance, these thoughts will aid in explaining congenital and queer constitutional peculiarities, and often inexplicable differences in races, families and individuals. It is a matter of common observation that in some families senile changes occur much more early than in others, and yet there may be little of degenerative change apparent or probable because of the vigor of the individual. As the gradual steps of growth lead to development, so does the phase of existence called senescence merge insidiously toward the ending called death, through a progressive and insensible diminution in all the organic activities. Death should be regarded as a normal function. Ordinarily it is free from pain and hence should be free from sadness.

Obesity.

Excessive fatness, or polysarcia, is not confined to advancing years, it is observed at all ages; but the quality of the accumulation in early years differs from that seen in late middle life. During the earlier years excessive gain in weight is usually the product of full digestive capacity with a somewhat lessened eliminative power and can be met by reduction in diet and active exercises, and is, as a rule, controllable. With that form of obesity which is not altogether manageable in young people or those on the hither side of middle life we have nothing to do, except in so far as we should discuss this condition and its progress when encountered in later years. Again in women

more particularly, there is oftentimes a sudden gain in weight, sometimes to a very annoying and disabling degree, following the change of life. This is an abnormality, and is sometimes based upon pathologic changes in the thyroid gland analogous to myxedema. In men at about the same relative period an enormous gain in weight occasionally arises and is a serious annoyance and anxiety. A few points in regard to the control and reduction of this warrant discussion, although they need not be elaborated. Where this gain in weight seems to be free from any abnormality except difficulties in the elimination or utilization of fat, it is proper to initiate active treatment by careful diet according to the methods of Banting, Ebstien, Oertel, along with specially directed exercises. In persons who are obviously not vigorous, as in those instances where marked anemia is present, there should be a careful search for evidences of disease beginning, or established, and treatment for the condition outlined accordingly. Von Noorden emphasizes the necessity of being on our guard in treating conditions of obesity which arise in women from fifty to sixty years of age. The greatest precautions must be used in dealing with these, because under almost any régime they will lose strength, frequently to an alarming extent, and what is more fail to regain it. The same statement holds good, to a less degree, in men of the same age. It would be interesting to formulate the different kinds and degrees of obesity and the pathologic changes which often accompany this state, forming it may be the cause on which the obesity arises, or again the results, direct or indirect, of the excessive weight. It is enough for our purpose here to offer some directions as to how this objectionable state may be relieved without producing harm. First, it is necessary to bear in mind that under the direct advice and continued attention of the physician is the only safe mode of procedure. Where there is found, as often happens, marked weakness of the heart and circulation the greatest care must be observed, and measures should be adopted having direct regard for the possibilities of the individual and varied from time to time under intelligent supervision. It is always a dangerous thing for persons to undertake their own treatment for obesity if they make use of drugs, because great harm can be done; it may be irretrievable. There is no objection, however, to moderating the diet, increasing exercise, and, above all, to employing systematized physical training for the purpose of improving elasticity in all the tissues. It is only safe to do so under medical advice. Oertel in 1885 and after, has done work which marks an epoch. The principle upon which he proceeds is that even where there is found to be pronounced weakness of the heart muscle, and other disturbances in circulation, these may be met by steadily increasing the amount of physical work done, especially by hill climbing. This walking up slopes has the merit of bringing out skin

moisture and taxing the respiratory capacity much more promptly and completely and is more capable of regulation than any other form of exertion, at least any which would be admissible. It is only possible for people relatively young or strong to begin in this way. Our subject is polysarcia in people of advancing years, and hence greater caution must be exercised in outlining activities than for younger folk. The general principles of exercises given at the end of this paper need not be repeated here, but should be read in connection with the measures now to be outlined. In over-stoutness of late middle life, accompanied by good health, it is essential to use first fairly active increasing extensor movements with elasticizing measures, active and passive stretchings, loosening up of the hip joints particularly, and above all, thorough drill in regaining proper attitudes. This should be followed by systematic, accurate training in breathing till a normal capacity is attained, almost never found in stout people unless acquired through teaching. In a paper elsewhere I have elaborated these thoughts (*Internat. Med. Magazine,* July, 1901).

When we have to do with the fat anemic person vastly more care must be used. The heart in these cases is likely to be infiltrated by fat and the muscular fibers clogged and inelastic, and must be taught slowly to regain their contractile vigor. At first, climbing stairs under direction is about as much as can be attempted, and any house will serve, merely regulating the number of steps walked up and down (both being of benefit) and the rate of speed carefully specified. Tall office buildings serve admirably for the purpose. Polysarcia is such a disabling condition that it is well worth prolonged remedial efforts. Success is possible, and indeed always probable, within limitations. The unaided efforts of the patient can readily lead to harm, sometimes calamity. There is one essential rule in dealing with the cases under consideration, and that is the time for treatment can not be measured by weeks, should not be measured by months and can only safely and satisfactorily be measured by years. One instance will help to illustrate my point. I had a gentleman under my care of sixty-one years of age, who had learned to ride a bicycle before meeting me and found it impossible to use this much because of the distress it produced in breathing. I saw him only rarely at intervals of months, and advised him by letter chiefly in connection with his own physician. He was advised to adopt the rule of riding regularly but briefly on the level roads of his own country place. After some months these short excursions produced no distress. In a year's time he was able to start out upon the open roads, but was compelled to dismount at every small rise of grade. In another year he was able to ride up moderate grades on a good road. At the end of the second year he was riding with comfort and pleasure. At the end

of the third year he rode all about the country where the roads were good and for hours at a time. The loss in weight scarcely showed in the first two years, but after that it was sufficiently great to be satisfactory. At the age of seventy-six he feels himself to be all of twenty years younger than when he began.

The Menopause.

There is a time about the middle of the life of women which is called the critical period and is supposed to be fraught with many dangers and grave disturbances. This period of the climacteric has been grossly exaggerated, and it is by no means necessary to look forward with dread to the time when menstruation ceases. Man reaches the period of highest development at forty-one years, and woman at thirty-nine. The following seven to ten years may be called the age or epoch of invigoration in both the sexes. The tissues have then become most stable and the nutrition of the body is at its best. It is one of the epochs of development and naturally is accompanied by certain characteristic features. In man these epochs are marked as follows: Dentition, pubescence and the climacteric of age. These are all practically developmental phases, although the last is usually accompanied by degenerative changes in one or another vital organ by which resistance in the tissues is lessened, allowing relatively slight influences finally to cause death. In woman there is generally recognized another, styled the change of life, or menopause. Modern investigations seem to demonstrate beyond a doubt that this change of life is merely a conservative process of nature to provide for a higher and more stable phase of existence, an economic lopping off of a function no longer needed, preparing the individual for different forms of activity, but is in no sense pathologic. It is not sexual or physical decrepitude, but belongs to the age of invigoration, marking the fullness of the bodily and mental powers. There are rather more decided changes in the blood-making and blood-elaborating organs in women, toward the end of life, than in men. Man's greater activity enables him to escape this contrast, because as a rule he has called more upon his motor machinery in using up injested and assimilated material. The life of woman leads her to become more impressionable and to watch over her menstrual days, think of them, make allowances for the exigencies which may arise at such times, and to expect various disturbances and discomforts. If her mind becomes fixed upon some one small ailment or other, especially connected with this function, there is almost an inevitable hyperconsciousness and a continuance or an exaggerated degree of attention which is practically hysterical even in the best of women. Such disturbances as do arise about the time of the menopause are largely due to a normal failure of the organism to

offer the same degree of resistance to intestinal and other poisons, and the great eliminating organs begin to exhibit a gradual lessening in functional activity. The theories of immunity rest upon the assumption of the presence of some proteid body in the blood which endows the whole system with powers of resistance to toxins. Exhaustion, especially such as is induced by the emotions, fatigue, grief, anger and fear, are well known to weaken the protective power of these mysterious agencies. At the time of the so-called change of life, woman is usually burdened with the maximum of her cares and labors and too often at this time the severest griefs assail. If she be single there is a species of spiritual awakening and the realization that youth is utterly past. In married women the disappointments which follow upon enthusiastic expectations become manifest, and in numberless ways strains are thrust upon the organism. It must be remembered that the greatest maturity of the powers, also, are evident at this time, and therefore she should be capable of meeting all exigencies. The whole question may be summed up in a few words: if a woman, married or single, will so order her life that she retains to the best of her ability her physical and mental vigor, and if she also sets her face sedulously toward looking upon the bright side of existence and ignores emotional impressions of a disagreeable character, she has nothing to fear as life moves steadily on the downward incline.

THE ROYAL PRUSSIAN ACADEMY OF SCIENCE. BERLIN. I.*

By EDWARD F. WILLIAMS,
CHICAGO, ILLINOIS.

History of the Academy from its founding by Leibniz and the Elector of Brandenburg in 1700 to the death of Frederick William I. in 1740.

THE history of the Royal Prussian Academy of Science is in reality the history of the development of science in Prussia, one may say throughout the territory covered by the present German empire. Founded July 11, 1700, by the Elector Frederick III. of Brandenburg at the solicitation of his wife Sophie Charlotte and of Leibniz, it not only gave an impulse to scientific research and scholarly investigation in every department of learning in Berlin and throughout Prussia, but became the model after which other societies with similar aims in the German-speaking world were brought into existence. Not quite as old as the French Academy nor as the Royal Society of Great Britain, nor as the Lincei in Rome, it has done as good work as any of them and exerted quite as wide an influence.

The period embraced in its life covers the period of the reconstruction of the German university and its growth from the unsatisfactory institution of the first quarter of the eighteenth century to its present commanding position in the world of learning. It covers the period in which the *gymnasia* were remodeled and the foundations laid of that system of common schools (Volksschule) for which Germany is now famous. It covers also the period of French oppression, of the reawakening of the national spirit and of the contests which secured political freedom and a united German empire.

In 1694 the Elector Frederick founded the University of Halle, not long after, the Medical Society of Berlin and, in 1696, the Academy of Arts. He assumed the rank of king on January 18, 1701. He inherited a love of poetry and of learning from his father, the Great Elector, who refounded the universities of Königsberg and Frankfurt and brought the University of Duisberg into existence. He had planned also a universal university at Brandenburg to be free to

* For the facts presented in this article the writer is chiefly indebted to Professor Adolf Harnack's masterly history of the academy in four quarto volumes, although other sources of information have not been overlooked.

all the world, an asylum for all students of science and art, and to be undisturbed even by war.

Leibniz (1646–1716), though unwilling to break with the old learning which the universities cherished, had breathed the breath of the new learning which came in with the Renaissance and the Reformation. Holding fast to all that was valuable in the traditions of the past, he early became an ardent advocate of the new methods of study which science, even in its beginnings, introduced, and through the founding of academies in the great capitals of Europe sought to unite the tendencies of the time with the protestant spirit of research and criticism. A many-sided man, philosopher, theologian, jurist, politician, philologist, physicist, an acute observer, fond of experiment, with a constructive mind, restless in his eagerness for knowledge, he did more than any man of his era to forward the study of nature and to emphasize its unity. Through the establishment of an academy in Germany under royal patronage he thought he could demonstrate the harmony of the world in study and research and realize the unity of human society. His first proposal for a society for the study of science was made in 1667 when he was but twenty-one years old, his last only seventeen days before his death. He suggested and furthered, so far as he could, the union of all the learned societies of Europe, a plan which has been partially realized in our own time. He lived in Hannover, where he made himself useful to the Brunswick princes as a historian, although he did not possess their complete confidence as a politician. Having observed the working of the French Academy when on a visit to Paris in 1675, the following year he proposed a German academy somewhat on its model, and even named the forty-eight men who were to compose it. He proposed later, as protestants seemed indifferent to his project, that the Pope divide the fields of learning among the catholic orders, assigning the study of nature to the Benedictines and Cistercians, that of law to the Dominicans and the Jesuits, that of language to other orders, and to the Franciscans the care of souls. If the princes of the House of Brunswick failed to give him their entire confidence, he had an unfailing friend in the Princess Sophie (1630–1714), daughter of Frederick V. of the Palatinate, and mother of George I. of England. It was through her daughter, Sophie Charlotte, who married the elector of Brandenburg September 28, 1684, and who had been educated under the eye of Leibniz, that he realized at last his hope of founding an academy in Berlin. Of this woman Frederick the Great said she had both 'the spirit of society and of true culture,' and that 'she brought the love of science and the arts into Prussia.' She was a gifted, charming woman, and so eager for knowledge that even Leibniz was wont to say of her that she was never satisfied with reasons which were sufficient for others, she 'must know the why of the why.' Although Leibniz

even in the decade from 1681 to 1691 had a low idea of the culture of Prussia, he was not long in discovering that it was only under the leadership of the Prussian elector that the German protestant states

Godefroy Guillaume Leibnitz
né a Leipsic le 3 Juillet 1646
mort a Hanover le 14 Novembre
17 16.
Il fut dans l'univers connu par ses ouvrages.
Et dans son Païs même il se fit respecter;
Il instruisit les Rois, il éclaira les Sages.
Plus sage qu'eux il sut douter.
M. Voltaire
a Paris chés Daumont rue St Martin

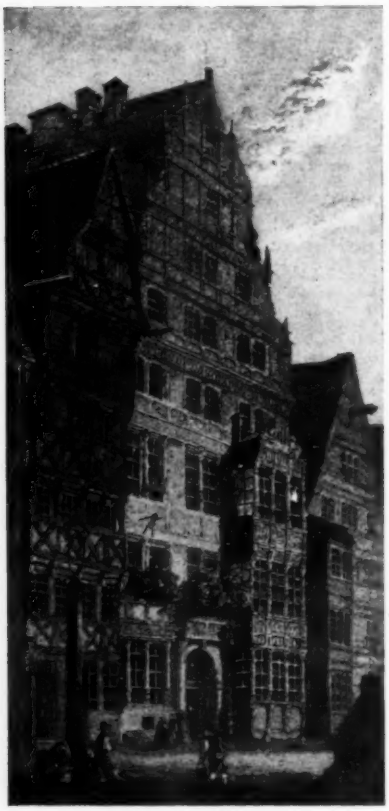
could be united in an academy. Hence his efforts to interest Sophie Charlotte in his enterprise. Through Prussia, he wrote her, he 'saw the gateway to Russia, and through Russia the gateway to China.'

For political reasons, probably, there was no regular correspondence until 1697. Meanwhile Leibniz had interested many scholars in his project, among them Count von Dunckelmann, in whose parlors scientific meetings had been held in Berlin for ten years. Jabloniski, a Bohemian by birth, court preacher in Berlin, a man of great knowledge and natural ability, was one of the most efficient aids which Leibniz had in bringing the academy into existence. Much had been said about establishing an observatory in the Prussian capital. The wife of the elector exerted all her influence in favor of it as early as 1697. From this time on the clearly formed plans for an academy with which the observatory should be connected were carefully discussed. In a letter to the Princess Charlotte, dated December 19, 1697, Leibniz writes that he has been invited to Berlin, 'the cradle of the arts and sciences,' where 'Solomon and the Queen of Sheba are.' While on a long visit in Hannover during the summer of 1698 the princess had opportunity to discuss with Leibniz, unhindered, their plans for an academy and scientific institute in Berlin. Jabloniski was sent to Hannover by the elector to see Leibniz and returned to Berlin greatly impressed with his ability, and urged the elector to invite him to the city. This was done through the Princess Charlotte. For more than a year little progress in founding the academy was made, though the leading scholars of Berlin desired it. Means for its support were wanting. Aid came from an unexpected source. Professor Erhard Weigel, of Jena, was anxious to correct the calendar, and Leibniz at once saw that if this corrected calendar were made a monopoly the cost of an academy could be paid out of the profits on its sale. Messrs. Rabener, Curveau and Jabloniski memorialized the elector, the monopoly was granted and an order for the formation of an academy, with which the observatory was united, was issued on the day the memorial was presented. Leibniz, who had recently been made a member of the French Academy, was appointed its president. On January 18, 1701, Prussia became a kingdom and the elector a king.

The academy began its life under favorable circumstances. Although the means of support were inadequate, the ideas of the men who formed it were large and comprehensive. The plans then made, visionary as they seemed to some, have since been fully realized. Councilor Albinus, Chauvin, Dr. Jaegewitz, Naudi, the mathematician, Chief Engineer Baer, Privy Councilors Rabener and Cuneau, and Jabloniski, the court preacher, made up the eight who with Leibniz formed it. They were all imbued with the spirit and the ideas of the president. The academy was to be a place where the study of physics, chemistry, astronomy, geometry, mechanics, optics, algebra and similar useful subjects should be furthered. Not all of these branches of study were to be pushed at once, no one of them until men eminent in each

of them could be brought to Berlin and elected to membership in the academy. The statutes of the academy were framed after those of the French Academy and the Royal Society of Great Britain. Leibniz was to live in Hannover, but to come to Berlin when necessary and to have the expenses of the journey paid. The astronomer Kirch alone was to receive a salary. Kirch moved from Guben to Berlin, took up his abode in the second story of the building which the government had furnished for an observatory, brought with him his own instruments, which were used in common with those the government owned, and trusted to the income from a calendar, which he himself was to make, for his support. The income from this source was estimated at about $1,875 and the expense for the president, the astronomer, his assistant, a secretary who should look after the business of the academy, a servant, instruments, books, experiments, printing, correspondence, medals and miscellanies, at a trifle more. Perhaps no great enterprise has ever been undertaken more confidently on the part of its leaders with such small pecuniary resources at its command. The elector wished provision made for the teaching and improving of the German language. To him should be given the credit of forming the philological-historical department of the academy. To his wife belongs the credit of establishing its astronomical department, and to Leibniz of its scientific departments. It was gravely proposed by Leibniz that the academy should be also a missionary institution and should send the gospel to the heathen. On this ground the churches might be asked to contribute to its support. He would have it look after the sanitary condition of the homes of the people, and the character of their food. He had many plans for an increased income, but none of them proved effective. Even the calendar monopoly met with opposition from booksellers and was obtained with some difficulty. The letters actually forming the academy were dated July 11, 1700, the elector's birthday, and by them its members were required to give careful attention to the German language and history, and especially to the political and ecclesiastical history of Brandenburg. The elector made himself the protector of the academy, but directed it to govern itself through a council of its own members. This council was to select and receive new members, subject to his approval. Three classes were organized, one for the study of physics and mathematics, another for the study of the German language, and a third for the study of literature. No provision was made for the study of philosophy, because Leibniz thought its principles unsettled, and that its interests would be best promoted by considering it in connection with other subjects. The members were divided into ordinary, corresponding, home and foreign, and honorary members. John Theodore Jabloniski, an older brother of the court preacher, was made secretary, and at the same time directed to perform the duties

of archivist, cashier, curator of the museum, overseer of matters pertaining to the publishing and sale of the calendar, and to act as a reporter for Leibniz. Many of the difficulties connected with the academy during its earlier years grew out of the fact that the two Jablonskis were so intimately concerned with its management. Yet the secretary was a man of rare learning, and in many ways well adapted to his position. His brother was a member of the academy for forty-one years, was deeply interested in it, and for some years after the death of Leibniz was the means of keeping it alive.



HOUSE OF LEIBNIZ AT HANNOVER.

During the first decade of its existence the academy did very little. Some of its members were jealous of Leibniz, but he paid no attention to this fact, and did his work as if nothing had happened. The king wanted the academy to add to the glory of his reign, but would furnish no means other than those which came from the calendar monopoly for its support. Kirch and his wife, who was his efficient aid, made the calendar accurate and trustworthy and gave what time they could to astronomical study. Kirch's astronomical work was confined to the study of comets, sunspots and variable stars. But the income of the academy only just kept it alive.

The French language was used in the discussions and reports. Indeed, at this time the French population of Berlin contained within its ranks a larger number of distinguished men than the German. It is not surprising, therefore, that so many of the leading members of the academy were for so many years of French origin. The progressive element of the city was French. Their preachers and authors were the only men in Berlin who could meet the Benedictine church historians on their own ground. The German element was well represented by John Leonard Frisch, director of the Gray Cloister Gymnasium, who did more work for the academy during his connection with it than any

one else. He found time to compose papers on the silk manufacture of Berlin, on insects and parasites, which were illustrated with his own drawings, and to begin an extensive work on birds. He was a student of the Slavic languages, and through his Latin dictionary, which one of the Grimms said would not grow old, contributed very much to German lexicography. As a student of chemistry he greatly improved the famous Berlin blues. In 1703 there were 22 members of the academy residing in Berlin, 19 in 1707, 20 in 1711, and at this time there were 32 foreign members. During the sixteen years which he led the academy, Leibniz wrote between five and six hundred letters on its behalf. This was in addition to the papers he contributed to its sessions and to the work he did on the two or three volumes it published.

The death of the queen, on February 10, 1705, was a serious loss to the academy as well as to Leibniz. Work on the building to be used as an observatory proceeded so slowly that the astronomer labored at a great disadvantage. Still he discovered a comet and made some valuable observations. He died after ten years' service and was succeeded by his assistant, John Henry Hoffmann, who was followed by the younger Kirch, who endeavored to carry forward and greatly extend his father's work. But the academy was cramped through lack of means. These were so small that it could only publish a brief report of an eclipse of the sun, and of a few meteorological observations made in Belgrade by Schutze. Fifty thalers ($37.50) were sent Christian Sturm, of Frankfurt a. O., for scientific observations which proved of little value, and seventy-five dollars were set aside for the purchase of a Hebrew Bible found in China.

As early as 1705–6 it looked as if the academy could not survive. Its condition was desperate. Leibniz came to Berlin on its behalf and was more successful than usual in securing the favor of the king, who at this time gave it twenty-one hundred thalers ($1,575) for the purchase of ground on Dorotheen Street which it still owns. Volume I. of the Berlin Miscellanies, edited by Leibniz and Cuneau, appeared in 1707. Yet in 1709 La Croze, the royal librarian, said the academy was 'a society of obscure men,' but its fame was soon increased by the

election to membership in it of Hoffmann, the famous physicist of Halle. In May, 1710, a quarto volume containing sixty treatises, twelve of them by Leibniz, was published. This indicated renewed life in the academy.

This year Leibniz was discredited by the king through the appointment over him of Minister von Printzen as president. This was done without consulting him and also without his knowledge, and as if to annoy him, a salary of seventy-five dollars was ordered paid to the heads of the four classes into which the members of the academy were then divided. These classes were physics, which included medicine and chemistry; mathematics and astronomy; the German language, to which the political and ecclesiastical history of Brandenburg especially were attached, and literature, a department whose members were also to consider methods for spreading the gospel among unbelievers. The government of the academy remained in the hands of a council formed by the heads of these classes with the addition of the *fiscus,* who was appointed by the king. Other members of the academy had no voice in its management. It was now decided that the sessions, which had been rather irregular, should henceforth be held on Thursday every week at 4 P.M., and that there should be a general meeting once a month, so that the whole work of the academy might be known to each one of its members. The public recognition of the academy was given on January 19, 1711, by the king himself. Leibniz excused his absence on the ground of ill

health, though it is easy to see that there were sufficient reasons of another character why a man of high spirit like himself should not be present. In the long and rather trite Latin oration by von Printzen, and in a second oration by Jabloniski, there was no mention of him, though the published reports give him credit for his services in founding and directing the academy. At this time the membership had increased to 38 or, if the honorary and acting presidents be counted, to 40.

The king died on February 25, 1712. The history of the academy under his successor, Frederick William I., is somewhat disappointing. Leibniz, though doing all in his power for the academy until his death in 1716, turned, in his later years, to other helpers than the king of Prussia for aid in his projects: to the king of Saxony; to the Czar, who met him cordially and made him many promises and to the government of Austria. Through these centers of learning and investigation he hoped to be able to direct and control scientific study on the continent of Europe.

Still the Berlin Academy was not without significance. Hoffmann the physicist was not idle. Work on a German dictionary was begun early in the new reign, but for reasons which do not appear it was given up in 1721. In 1712 it was decided to revise Luther's Bible and to begin with the New Testament, but, after working on this revision till 1743, it also was abandoned. Perhaps the failure of these great projects may suggest some of the reasons why the academy had failed during Leibniz's lifetime to realize the hopes he had cherished for it. In his day and for some years afterwards few scientific men of the first rank made Berlin their home. Moreover, the government of the academy was autocratic. Some of the best men in the city, men who ought to have been among its members, felt that they could do better work outside than within its ranks. There were some quacks in Berlin, like a certain Dr. Gundelsheim, who declined an election to the academy, characterizing it as a nuisance in the learned world, and useless, and so ridiculed and defamed its most prominent member, Hoffmann, as to compel him to leave the city. As Crown Prince, Frederick William had despised the academy. Penurious by nature, he cared little for any society or institution which sought merely to increase knowledge without regard to its utility. True, he continued the calendar monopoly, but cut off some other privileges the academy had enjoyed and commanded it to reduce expenses to the lowest point. He consented to preserve its life only on condition that it do something for medicine and technology. Leibniz saw the situation and did his best to persuade the academy to undertake a work which would gratify the king and secure his favor. For some reason it failed to heed his advice. Not till ten years later did Volume II. of the Berlin Miscellanies appear. Meanwhile the theater, which had been prepared for anatomical

study, was secured by Dr. Gundelsheim, who had gained the king's confidence, and made the center of bitter opposition to the academy. Although it contained the valuable cabinet of Spener, he alone of all the members of the academy was permitted to examine it. The observatory was compelled to pay rent for rooms hitherto furnished without cost, and subjected to the mortification of seeing rooms in the building which had been erected for its sole use offered for rent. Spener's death in 1717, just when he had begun to gain the king's respect and confidence, was another misfortune for the academy. Dr. Gundelsheim had now no one to oppose him. It need not be said that the academy soon suffered from his hostility. A full account of its expenses was demanded. The back salary due Leibniz remained in arrears, and after the king had looked over the balance sheet, he reduced the salary which had been only $450 one half, and ordered the $75 saved in this and other ways paid to Dr. Gundelsheim. The reduction of the salary of the president seems to have caused little sorrow in the academy. Indeed it has been said that its members would willingly have cut it off altogether could the salary of the secretary have been kept where it was. Dr. Gundelsheim died in June, 1715. Meanwhile Leibniz, notwithstanding the ill treatment he had received, continued to exert himself on behalf of the institution he loved. He urged its members to greater efforts and sought to secure the publication of the second volume of miscellanies. But the death of some of the most faithful members and the indifference which the public felt toward it left its future doubtful. Jabloniski was easily its most influential member, as Frisch continued to be its most industrious.

Leibniz died on November 14, 1716. No settlement had been made for his unpaid salary and none was ever made with his heirs. He died in neglect. Hannover took no notice of his death, neither did the academy in Berlin. Fontenelle, by order of the French Academy, pronounced a worthy eulogy in his honor in Paris on November 13, 1717. This treatment of its founder will ever remain a blot on the history of the academy, although its observance of Leibniz Day in later years and at present indicates a better appreciation of his abilities and his services for science and literature than the men of his own generation seem to have had.

The history of the academy from the death of Leibniz in 1716 to the death of the king in 1740 has comparatively little significance. Its life was monotonous, far from what it ought to have been. With it the king could have little sympathy. His strength was in other directions than as a patron of learning. He laid the foundations of a prosperous state upon which his son wisely built. He impressed the people with the need of industry and economy, but he cared nothing

for science unless it proved itself useful. Nevertheless, useless as he deemed them to be, he disturbed neither the universities nor the academy. He contented himself with ridiculing the pretensions of the members of the latter and their methods of study. Yet he had some respect for the science of medicine and that of chemistry. In these two branches of study Berlin, during this period, was eminent. But apart from the Gymnasium Director Frisch and the Royal Librarian La Croze there were in the city no philologists, historians, jurists or theologians of the first rank. If the king permitted the academy to live, he took pleasure in crippling its resources and in compelling it to pay salaries to men outside its membership, men who experimented in medicine and chemistry and were willing to carry out his wishes. During the period 1716–1740 only five volumes of miscellanies were published aside from the observations which appeared in the calendar. The fate of the academy might have been better had it issued, as Leibniz wished it to do, a volume every year.

Sixteen months after the death of Leibniz the vacant presidency was filled by the appointment to it of Jacob Paul Gundling, a man of considerable knowledge, a fine story teller and the butt of the king's wit. He was the author of about a dozen volumes on historical and economic subjects, but was drunk a good deal of the time and altogether unfit to hold an office to which a man like Leibniz had given dignity. Thirteen years later, in 1733, acting on the advice of minister von Vierecke, the king made Jabloniski president and the academy began to show signs of a new life. A few famous men had settled in Berlin and some of them had accepted membership in the academy. But complete deliverance came only with the king's death and the accession to the throne, May 31, 1740, of his son Frederick the Great, who in almost all respects was the opposite of his father. This was the beginning of the new era, an era in which French thought prevailed, the era of Maupertuis, D'Alembert and Condorcet.

THE TROPICAL STATION OF THE NEW YORK BOTANICAL GARDEN, AT CINCHONA, JAMAICA.

THE TROPICAL STATION AT CINCHONA, JAMAICA.

By Dr. N. L. BRITTON,
DIRECTOR-IN-CHIEF OF THE NEW YORK BOTANICAL GARDEN.

A GREAT need in the formation of the collections of tropical and subtropical plants of the New York Botanical Garden and elsewhere in the United States has been a suitable place in the American tropics where seeds could be germinated and cuttings and seedlings grown under natural conditions for periods up to two or three years, before their transportation. Plants can be germinated and grown under glass, but in many instances it is desirable or even necessary that they should be cultivated in the open, and the care of such nurseries is far less expensive than that of propagating houses. Larger plants collected in the tropical forests are also transported to the temperate zone only with difficulty and with considerable loss unless they have been again rooted in the tropics and sent north in pots or tubs, sections of bamboo stems being readily available for this purpose. I came to realize this condition on my trip to the West Indies in the autumn of 1901, in company with Mr. Cowell, director of the Buffalo Botanic Garden, and we discussed the project for the establishment of a nursery a great deal, and concluded that in order to make as complete an exhibition of tender plants as possible in our northern conservatories such an adjunct to our work was necessary.

During Professor Underwood's recent extended visit to the island of Jamaica, while pursuing his investigation of the ferns of tropical America, he learned that the building and grounds of the colonial government at Cinchona were offered for rental and he at once communicated this fact to me. It has long been the desire of all American botanists that arrangements should in some way be made for a laboratory in the American tropics, to which investigators could conveniently go for the purpose of carrying on studies of tropical and subtropical plants growing under natural conditions, instead of under the necessarily artificial conditions which glass houses afford in the temperate zone. This matter was taken up as long ago as 1897, when the island of Jamaica was visited by Dr. D. T. MacDougal and Professor D. H. Campbell, who, at the request of other American botanists, made an examination of available sites for such a laboratory, and decided that this very place, Cinchona, was the one probably best adapted to the purpose in view. At that time, however, the Department of Public Gardens and Plantations of Jamaica was using these buildings and grounds as a part of their agricultural and horticultural system

of gardens and experimental plantations, and this, together with other reasons, caused the postponement of the movement.

During the autumn of 1902 Mr. William Fawcett, the director of the public gardens and plantations of the island, was in New York, together with Sir Daniel Morris, the imperial commissioner of agriculture for the British West Indies, and at that time the matter was discussed again with them, and this gave an emphasis to the reconsideration of earlier plans, for both nursery and laboratory. The decision of the colonial government to rent Cinchona, and transfer most of the work there carried on to other plantations, was reached

A Laboratory at the Tropical Station, Cinchona, Jamaica.

only last summer, and as it was feared in Jamaica that the property might be diverted from its most desirable purposes, I concluded, after consultation with a number of persons interested, to assume the rental of the property, with the idea of carrying out both plans if possible. Dr. MacDougal immediately went to Jamaica, after Professor Underwood's return, and made the necessary arrangements for the lease and for the caretaking of the property. I communicated this action by mail to over sixty of the botanists and horticulturists of this country and Europe, who expressed the most enthusiastic appreciation of the scheme. My action was approved by the scientific directors of the New York Botanical Garden in October, and arrangements have since

been made to commence the carrying out of plans both for the nursery and the laboratory, in cooperation with the Department of Public Gardens and Plantations of Jamaica.

The government of Jamaica began cultural experiments with *Cinchona* in 1860 with seeds sent out by Sir Joseph Hooker, from Kew, and after preliminary trials a tract of six hundred acres of land on the southern slopes of the Blue Mountains between the elevations of 4,000 and 6,000 feet was set aside as a plantation in 1868 and forty

A LABORATORY AT THE TROPICAL STATION, CINCHONA, JAMAICA.

acres planted with five species of *Cinchona,* the quinine trees of the Andes. A number of other trees from various parts of the world were also introduced and still flourish in this location. The reservation was increased at various times until the areas used for various experimental purposes included much more extensive plantations at the above and at lower altitudes. Headquarters for the work were established on a spur extending southward from the main range of the Blue Mountains at an elevation of about 5,000 feet. It is this central station with about ten acres of land, designated by the Jamaican government as Bellevue House and Grounds, that has been secured for the use of the garden.

The buildings include a furnished residence, stable and servants' quarters, two glass houses, three buildings suitable for laboratories and

offices, a storehouse and a small building designed for lodging visitors to the station, the entire suite being admirably adapted for the purposes for which it has been secured.

The grounds contain a large number of introduced ferns, shrubs and trees, together with many native species. The valley of the Clyde River at an elevation of about 3,000 feet is within a mile; New Haven Gap and Morse's Gap, three miles distant at a level not much different from the station, furnish unequaled opportunities for the examination of a primitive tropical forest. The summit of John Crow peak may be reached from Morse's Gap, and here at an elevation of 6,000 feet the forest of tree ferns is so luxuriant that a view of the surrounding lower country is obtained with difficulty. The wealth of ferns, hepatics and other lower forms as well as of seed-plants that may be found here is remarkable. In addition, the flora of the coastal region of the island, and the vast collections in Hope Gardens and Castleton Gardens place within easy reach of the visitor an enormous number of species native to regions with a range of conditions from the most humid to those of extreme aridity. The algal flora of the coast is also easily accessible.

The government record proves the general climatic conditions prevalent at Cinchona to be very equable. Thus the lowest temperature reached in the winter of 1899–00 was 53.90° and the highest temperature of the following summer was 70.4°.

The station at Cinchona is in direct communication with Kingston, a city of 60,000 inhabitants, from which place nearly all supplies are obtained.

In addition to the facilities offered by the station at Cinchona, the government of Jamaica, by the courtesy of Hon. Wm. Fawcett, director of the Public Gardens and Plantations, has granted to the garden substantial privileges which will be of great value to visiting investigators. Among these may be mentioned the opportunities for study at Hope Garden, which lies near sea-level near Kingston, including the use of a table in the laboratory, and of the library of about twelve hundred volumes. Botanists are also to be allowed to withdraw books from this library for use at Cinchona under conditions imposed by Mr. Fawcett. Castleton Garden and the other plantations of the government are likewise open to the student.

All persons who may apply for permission to study at Cinchona must submit such evidence as the director-in-chief of the New York Botanical Garden may require that they are competent to pursue investigation to advantage. While in residence at Cinchona they will be under the supervision of the Hon. William Fawcett, director of Public Gardens and Plantations, to whose interest and advice the establishment of this American Tropical Laboratory is largely due.

EDUCATION AND INDUSTRY.

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EDUCATION is one of the most important undertakings of life. Of the four great institutions by means of which society accomplishes its purposes, the home, school, church and state, the institution which reduces education to systematic form is one. The evolution of society involves all these institutions in a constant process of readjustment to new conditions. Every great social and industrial change has therefore rendered necessary readjustment of the system of education in use.

In countries where political privileges are restricted to a few and where economic conditions are stagnant, passport to society is the knowledge of a mass of traditional lore chiefly theological and metaphysical in character, supplemented by the rudiments of the exact sciences. The Renaissance unlocked for Europe the wealth of classical learning and the fraternity of the learners speedily came to consist of those who had received this knowledge and who could discuss it through the vehicle of the classical languages. The rapid drawing back of the curtain of mystery from the face of the earth during the age of the discoveries and the subsequent slow development of the natural sciences introduced a third great element to the curriculum of educational institutions; namely, science. The organization of the great states of western Europe necessitated the study of politics, history, jurisprudence and public finance. Eventually a home-grown culture in western Europe and America made possible the profitable study of modern languages and literatures. And now comes a new condition, the result of a recent and wonderful evolution, destined to influence the place and function of the school in society as powerfully as any of those that have gone before it. The growth of industry from the crude methods of the handworker, following the dim lights of tradition, to the cooperative effort and applied science of modern times, paralleled as it has been by the evolution of commerce from venturesome and piratical expeditions to a world-wide exchange of goods, which has become as essential to modern society as the circulation of the blood is to the human body, has again made necessary a modification of educational institutions. This marvelous evolution of industry and commerce has created material for an important group of new sciences, has brought into existence many new professions, and it forms a new world of human endeavor in which new culture and new and worthy ideals must be created and held aloft. Here is room for the work of the school as a patron of

research, as a teaching institution, and as a champion and evangel of high ideals.

Inasmuch as a major portion of the time of a considerable fraction of the human race has been long engaged in earning a livelihood by means of those industrial pursuits for which the school is now beginning to formulate a specific course of preparation it is not remarkable that this kind of education is now engaging public thought, but rather remarkable that it should have been so long neglected.

The organization of a national system of education adequate to prepare for industry involves the many-sided problem of providing for the needs of each of the main classes of persons found in industrial society. Such a system must provide for the workmen who compose the rank and file of the mechanical or operative departments of a business, and it also must give the scientific and technical training required by the managers and superintendents of those departments. It must include training for the office force which composes the executive branch of that part of a business which has to do with the financial and commercial policy, and finally it must provide an adequate education for those who determine and superintend the execution of this policy.

We may therefore divide the school equipment, which has been provided specifically to prepare young persons for commercial and industrial pursuits, according as it relates to one or another of the above classes, distinguishing: (1) Trade and manual training; (2) professional and technical education; (3) training for office work, and (4) higher commercial education.

Trade and Manual Training aims to produce the skilled artisan; and this it endeavors to do by giving the youth, in addition to his general elementary education, a further mental equipment, involving the knowledge of the qualities of materials and the methods of manipulating tools, machinery and materials to attain desired results. It also aims to give him a knowledge of the proportions necessary to secure strength or beauty, and the capacity to see the possibilities of materials and of his art. There is necessarily an important physical element involved in this kind of training. Not only must the mind be receptive, but the eye must be taught to see things as they are; not only must the imagination be awakened, but the hand must be skilled to execute the conceptions of the mind.

The subjects usually taught in manual training schools are free hand and mechanical drawing, clay modeling, carving, sewing, cooking, carpentry and forging. These subjects are appropriate for students between the fifth and eighth grades. They are chiefly taught in the public schools, being found in 1899 in the schools of 170 American cities. At the same period, however, there were 125 private schools teaching manual training.

In previous industrial periods a supply of skilled artisans, though

not an adequate one, was secured by the handing down of the traditions of craft from father to son. This method was suited to the household system of industry. At a later time the supply was made sure by a careful supervision of apprenticeship, and this proved successful so long as the shop system endured. The dominant industrial organization previous to the introduction of the factory system was the guild—an institution which, in addition to other duties discharged, made itself responsible for the regulation of apprenticeship and for the preservation of standards of workmanship. These standards it was able to fix since it included both masters and workmen, and it maintained them by means of the masterpiece, the trade-mark and the power of excluding incompetent workmen from the trade and inferior articles from the market. The present industrial system has broken down all these regulations. The traditions of craft do not preserve validity long enough in this age of rapid mechanical evolution to be handed down with profit from father to son. The freedom of choice of occupation and the constant ebb and flow of population between producing regions now prevent the accumulation of any great store of traditional skill and knowledge among the workmen of any one locality. The factory system has rendered apprenticeship impracticable, not only because there is no time for the employee to teach and the novitiate to learn, but because the subdivision of labor is so great that a systematic progression of tasks must needs be arranged to give the beginner even a comprehensive knowledge of a rule-of-thumb character concerning a trade; and this the modern competitive institution is usually not in a position to grant. Furthermore, the guild has disappeared and in its place have come the trades unions, composed exclusively of employees, and having as their primary object warfare through the strike to secure higher wages and shorter hours of labor. The trades unions have not undertaken to set standards of excellence in workmanship or material as did the guild, nor can they do so, for they do not control the processes of industry as did the guild. The attention paid by them to apprenticeship is not for the purpose of educating the artisan but to restrict the number of persons in a trade and so affect wages.

The old system has crumbled to pieces, and yet never was there greater need of an intelligent artisan class than at present. Never have the machine and the routine of production so threatened to dwarf the worker; never has there been more wealth under the control of those of artistic aspirations ready to pay for the best creative work of the artisan. Never has there been greater need of joy and pride in work and healthful mental stimulus in it to offset the deadening effects of a narrow spirit of commercialism; never has society more needed a sound middle class capable of right thinking and sufficient initiative to hold together the extremes of wealth and poverty that our wonderful economic system now produces.

The school is called upon to provide the education necessary for the artisan, and this it can do better than the practice of an industrial art alone, because it can arrange such a gradation of tasks as will insure the most rapid and permanent acquisition of skill and mental power. The school can give manual training without interrupting the general education of the youth. As dexterity in some lines is easiest acquired in youth, it can insure this without the waste of mind and body involved in child labor. The school, furthermore, can constantly relate the precepts of the arts to the principles of the sciences on which they rest and can add to this an artistic education which will awaken ability beyond that which any training in the workshop or factory can evoke.

Professional and Technical Education is of a more advanced order, and therefore not only requires more expensive equipment so that it is limited to a relatively small number of institutions, but is divided into professional courses corresponding closely to the professions and to the customary groupings of productive industries. This branch of education requires little explanation, let alone defense, in this country. It is the earliest form of education for industry to be developed here and it has passed beyond the experimental stage.

Of professional schools there were but two in this country at the time of the declaration of independence, and these were both medical schools. In 1899 the Commissioner of Education reported 917 professional schools, including schools of theology, medicine, law, pharmacy, dentistry, veterinary science and training schools for nurses, having a total attendance of 65,152.

As an illustration of a technical school we may cite the Rensselaer Polytechnic Institute of Troy, N. Y., one of the first of its kind in this country. It was founded in 1824 and, because of its early start and high rank, has exerted a great influence upon American railway engineering. The Philadelphia Textile School, the New York School for Carriage Draftsmen, the Michigan Agriculture College and the School of Mines of the same state are institutions of this class, as are the many polytechnic, mechanical and agricultural schools of the country, and schools of forestry, architecture, etc.

Through the liberality of the federal government many excellent agricultural colleges now exist in the United States, but a wonderful future lies before our agriculture when it shall be thoroughly permeated by the modern scientific and system-loving spirit, and its various branches shall follow the dictates of science, under the guidance of trained men. This the recent history of the dairy industries amply proves. The mineral industries of this country have been conquered by scientific experts within the past fifteen years, and the recent improvements in smelting and refining are due to men from the universities and schools of mines. The manufacturing industries of this country in a like manner need and can greatly profit by a steady supply

of technical experts who shall do for us what the graduates of German schools have done for the German chemical and textile industries.

Training for Office Work has remained in the hands of private institutions for the most part in this country. These schools, usually known as 'commercial colleges,' aim to fit young people of both sexes for clerical positions in offices and for employment as bookkeepers or stenographers. The chief subjects taught are penmanship, correspondence, stenography, typewriting, commercial arithmetic, bookkeeping and 'business practice.' The demand for persons to fill clerical positions has steadily increased for many years owing to the development of systems of stenography and to the invention of the typewriter and to the more elaborate form in which the record of business transactions is now kept. As the size of the individual business has increased and the territory covered by its operations has widened and the period of time involved in its calculations has lengthened, the need of carefully kept records has become apparent. The growth of the corporate form of business organization, furthermore, has made it necessary to protect the interest of shareholders by complex systems of accounting, involving sufficient checks and balances and frequent audits.

The 'commercial college' has responded in a more or less unsatisfactory manner to the calls made upon it. This is due in part to the fact that they are private institutions, run as money-making businesses, and without any uniformly enforced standards such as they might have attained for themselves through organization, or such as are enforced upon preparatory schools and high schools by university requirements for admission. Studies may be pursued in them in a wholly elective manner, as fees are paid, and so it has happened that they have been used as an educational short-cut by scholars of every variety of ability and education from the high school graduate, who may spend a year or more in them, to the youth from the country district school, who may study for two or three months. In accounting for the unsatisfactory work of this system of schools as a whole two other circumstances should be taken into account. One is that the business community has been expecting a kind of education from them which they were not organized to give and are not in a position to give, and the other is that educators who are capable of giving assistance have, for the most part, not assumed a helpful attitude toward the problem presented by them.

The aggregate of interests represented by these schools in this country is enormous, and the problems connected with them are serious and merit attention. It has been estimated that there are now 2,000 'commercial colleges' in the United States, employing 15,000 teachers, and having an attendance of 160,000 pupils. The best of these establishments in the large cities are handsomely equipped for the work they set out to do and amount practically to private commercial high schools.

In recent years this problem of education for office work has been

complicated by the establishment of commercial courses in high schools. The high school has the advantage in that it can formulate a systematic course of study covering the special training desired, and can couple with it a fairly adequate general secondary education. By having a larger scholar population and holding it for a series of years the high school is able, furthermore, to carry out in its commercial course a more ambitious program of study than the 'commercial college' with its floating population, and so it can group and systematize its work to the best advantage. It remains, however, to be seen what relation the public high school and the private school will eventually sustain to one another in this branch of education.

Higher Commercial Education is the effort of universities to respond to the call for a course of education which shall fit young men for the more responsible positions in industry. It aims to provide the theoretical and systematic part of the education of those who are to determine and execute the commercial and financial policy of businesses. It has more particularly in view at present persons who will occupy such positions as managers of departments, foreign agents and buyers of large concerns, officials of banks, insurance and transportation companies, merchants, journalists, government employees at home or abroad, as members of the consular and diplomatic service, etc.

There are three chief reasons why higher commercial education has become an imperative demand of the times and why the great universities of this country as of other countries are responding to the call made upon them by public opinion. These are briefly, that business has become an intellectual pursuit, that in business a sufficient training is not found for the adequate performance of its own tasks, and finally, that in the juncture thus created the universities are being actuated by a new, broad and constructive policy to take hold of the problem.

To consider these separately, the first reason is that the higher tasks and the more responsible positions of industry now involve an intellectual pursuit making profound demands upon the intelligence of those who undertake them. As Mr. Arthur Balfour, the first lord of the English treasury, has recently said, "In the marvelously complicated phenomena of modern trade, commerce, production and manufacture there is ample scope for the most scientific minds and the most critical intellects; and if commerce is to be treated from the higher and wider viewpoint it must be approached in the broader spirit of impartial scientific investigation."

The economic system in vogue before the industrial revolution hardly gave an opportunity for much of a science of productive industry or for systematic courses of study preparatory to the task of guiding industrial forces. That revolution enlarged the individual business unit through the use of machinery in connection with great sources of power, and of labor through an elaborate differentiation of tasks, the

result being to make the government of the internal affairs of a business resemble the work of governing states. It enlarged the market also by means of improved means of transportation and communication, and not only brought the entire earth into the field of commercial vision, but threw the new giants of production into such a keen and relentless competition that the utmost precision of knowledge, genius for administration and mental and physical staying-power has been sought after for leadership.

With these changes in progress and partly completed, industry has at once shown an irresistible tendency to come under the sway of science. A new concern of large size now starts with a charter and a plan of internal organization, the work of professional organizers and as carefully drawn as the constitution of a state might be. Eventually the mill architect lays out the plant. The head chemist and consulting engineer take charge of the operative departments; the conditioning laboratory checks off the results of the buyer's work; the credit man rules the selling agencies and compiles his data as systematically as the much-abused charity organization society; and the advertising manager works with a like systematic use of records. Risks are transferred, whenever possible, to insurance companies which study them with all the methods known to statistics. Legal liabilities are attended to by a special corporation attorney. All the records of the activities of the concern are compiled under the direction of the accountant and are periodically examined and certified to by a professional auditor. At every point the business has touched upon a science or a possible science.

This new régime, while it has given to industry such a character of intricacy, has given to its laws such precision, to its processes such rapidity and continuity, and to its leaders such a scope for power that men of systematically trained perceptive faculties and reasoning powers are required for it.

These methods also have already brought into view such a body of systematized experience that it is possible to begin the formulation of the principles of wealth production. And this will provide a subject-matter which can be studied apart from practice, according to the methods of an educational institution, and which will be of practical value because it has grown out of practice and governs it.

In an important sense the advance made by higher commercial education will condition the advance made by the other branches of education preparatory to industry, since the men in the responsible positions in our industry must needs have scientific and commercial training to appreciate its value in the men they employ.

The second reason for higher commercial education lies in the fact that it is becoming increasingly difficult for young men to acquire a knowledge of the principles underlying business through engaging in the activities of business. This is true if it is true that industry is

becoming applied science, for science is systematized knowledge, and systematic knowledge is only to be gained by systematic study. The division of labor now customary in a business of any size is such that a broad experience and knowledge of the business can not be gained from service in a subordinate position. Either there must be unusually favorable promotion from department to department, coupled with outside study; a plan followed by some of our prominent families in educating their sons, or an appropriate course of study must be arranged in an educational institution, or else we must fall back upon the chance of finding a man of unusual genius. We have in considerable measure been trusting to the most uncertain plan of all, the discovery of the self-made man of genius. As a result we have a tendency to build industrial organizations to undue size, the endeavor being to get important interests under the control of the comparatively small number of men who can be implicitly depended on. Thus we vastly overpay for the exercise of a certain kind of talent and run the risk of many industrial evils with our top-heavy system.

The tendencies of the industrial system now dominant, as regards the production of managerial ability, are, however, in considerable degree, still unrevealed to us because of a generation of remarkable leaders which has not yet passed from the stage of action and which was evoked by the evolution that built up our present magnificent national industries. These men began in the day of small things when a few hundred dollars sufficed to set up a manufactory with costs of production as low as others and with high tariffs and transportation rates to protect a market from outsiders. They grew with the industrial system. As their businesses grew their opportunities and experience and power grew by natural and easy stages, and they emerged from a nicely adjusted and progressive evolution knowing their industries from top to bottom. These men show the knowledge of detail due to the day of small beginnings and the even hand in administration due to gradually imposed responsibilities. In the future we can not with any confidence look forward to a succeeding generation recruited in the same way, for the system has changed. Unless the evolution of industry which trained the leaders of to-day can be simulated within industrial establishments by a system of apprenticeship broader and more scientific than the old as the new industry is greater than the old, and leading up to the highest administrative duties, then preparation must be arranged outside them in the school and university.

It needs scarcely to be pointed out that business is carried on primarily for the sake of producing wealth and that the machinery and method devised for this purpose is only incidentally of value as a training school for the young. To equip an institution specifically for the purpose it is to serve, whether it be to produce locomotives or cotton cloth, is well enough understood in these days of specialization. So

to equip an institution as to rapidly and surely and economically develop the latent powers of the mind required in business and to impart knowledge of practical value is simply to set about doing an educational work in an equally direct and logical way.

The very precision of organization which makes it so difficult for the subordinate to gain the knowledge and experience necessary for leadership provides the mechanism which most perfectly responds to the *entrepreneur* and endows him with power never before equaled in industry. Never was the capable manager more in demand than now; never was the hunt for the right man more anxious than it is now. There is not a more important question that can arise within industry than this one of proper management. How shall society insure the perpetuation of adequate leadership? This question is peculiarly pressing for the United States, not so much because of immediate needs as because we are bounding forward rapidly in our industrial evolution, framing greater structures of trade than the world has ever seen before.

Our great country lying in one continuous area, undivided by physical barriers and capable of furnishing every variety of raw material; in the possession of a progressive race with like degree of enterprise and honesty in all sections and employing the same trade usages and laws, possesses a capacity which a like area divided into many small states, although in the possession of an equal population of different races, could not have. No matter how large the industrial unit ultimately required to secure all possible economies of production, here the various raw materials can be secured, here all the branches of the business may be carried on without crossing the boundaries of nations and encountering tariffs and racial and national rivalries. Here business can be transacted with the utmost facility because among people with one language, system of money and weights and measures, and working with the same spirit of alertness and ambition, under one system of laws and customs. The United States may well be the country destined to test to the uttermost the possibilities of organization in industry.

But we shall not be without rivals in the world's trade. Countries which can not match us in resources and population will turn inevitably to more scientific and systematic methods. Already the Germans are applying the same methods to the preparation for commercial war that brought them out from the anarchy into which they fell after their defeat by Napoleon and made them the foremost military nation in Europe. England also is awakening to the necessity of applying education to the preparation for business life. Lord Rosebery, in a speech delivered before the Wolverhampton Chamber of Commerce which has since become celebrated, said, after reviewing the dangers threatening British trade from German and American competition: "What is the remedy for this? What is poor old John Bull to do before he is suppressed and defeated by these newer competitors? If I might say

a word it would be to echo what has already been said by the chairman —educate. I believe our raw material of men is the best in the world. But I do believe that our commercial men require educating, training scientifically from the bottom to the top. I believe that is a feeling which has become very common in this country. I see a great many articles now in the papers as to the decline of our trade, and several of our leading newspapers are, as you know, devoting articles to this subject, which I read with profit, but as to which I do not pretend to pronounce a definite judgment. But I do think all these articles, whether they be pessimistic or optimistic—and I am bound to say they are generally pessimistic—are united on this point of education."

Before we consider the adaptation of a university course to business training let us notice the various systems which have been or are now employed in educating or choosing young men who are designed for industrial leadership. The oldest system now in use is that of patronage, which still survives in France. This system belongs to a long established and somewhat static industrial community, in which advancement is slow and restricted to those who are specially favored. The solicitation of the favor of a distinguished relative or friend or local dignitary to assist in introducing a young man to a desirable position is in a sense only a rigid and systematized form of the rather loose system of recommendation everywhere in use, and, in a degree, it is as natural as the giving of favor to friends and relatives which is everywhere a factor in the preferment of many. To erect this into a system, however, is repugnant to the spirit of American youth and their employers. Allied to this is the English custom known as the 'counting-room system,' which consists in the placing of the son of a member of a firm in the business at an early age and graduating him rapidly from department to department in such a manner that when he finally obtains a junior partnership he has some knowledge of the operations of the business. The result of this plan is to keep businesses in families for generations and to create a spirit of family pride in the integrity and prosperity of a business which is heartily commendable. The Swiss as an industrial people are noted for the degree to which businesses are in this way kept within families. Some defects of the system are the tendency to coerce young men into occupations for which they have no taste or ability, the tendency to family exclusiveness and the neglect of young men who have only their merits to recommend them for promotion. This system is in reality a special form of apprenticeship arranged for the few.

Closely allied to the above is the recruiting of the managers of the colonial houses or foreign selling agencies of a concern from promising young men in subordinate positions in the home office and, in turn, recruiting the superior officers of the home concern from successful branch managers. This system of using the foreign offices as feeders

has played some part in England and is used in Germany. It has the merit of insuring to the home office accurate knowledge of the tastes, customs, laws and languages of foreign markets, and of keeping the home office and agencies in touch through the transfusion of blood.

Travel has for many generations been used in western Europe as a fitting supplement to the education of a young man at the conclusion of the period of schooling. It undeniably broadens the personality and develops culture through the variety of knowledge it imparts and the contact with people which it involves. It is, however, an expensive way of accumulating knowledge, and the knowledge gained is likely to be of a fragmentary and superficial character unless the traveler have uncommon tenacity and singleness of purpose. Before travel became the favorite recreation of the wealthy and the countries that have much to teach came to be deluged with the never-ending stream of sight-seers it was, perhaps, possible to gain in a short time valuable information regarding the industrial life of a people. Now the avenues of travel have been smoothed to a cosmopolitan sameness and these avenues lead to the 'sights' which, for the most part, convey little information of practical value to the young man preparing for commercial life. Meanwhile, since international rivalry in trade has become acute, the processes of production which might be studied with profit are being jealously guarded and kept secret from foreign visitors. So greatly has the system of news gathering improved and so voluminous and accurate have become the reports of consular officers that the traveler abroad must often return home to learn from literature easily accessible facts that are difficult to acquire through personal observation. Travel is quite appropriate for a people that have everything to learn and desire to import *en bloc* the system of older developed commercial states, but for a country having marked characteristics of superiority and possessing the lead in many things the problem of keeping this preeminence is not solved by any scheme of borrowing ideas, no matter how systematically and intelligently carried out. It is deserving of notice, however, that travel may be utilized by American manufacturers to a greater degree than it has been to give them a knowledge of the tastes of their foreign customers.

Education abroad is in many ways analogous to travel. It has been employed in recent years with success by Japan and is best adapted to the requirements of a nation taking its first steps in a new culture. For the United States this plan has many of the limitations of foreign travel, and it carries with it the added danger that the young man who remains abroad for a long season in the formative period of life will find himself on return out of touch with the ideals and customs dominating the industrial society in which he is to live, and that thereby the effectiveness of his personality will be greatly decreased.

These are some of the methods which have been devised to improve

upon the wasteful state of individualistic struggle in which the leader is chosen through the survival of the fittest simply as the exceptional man is able to fight his way up from the ranks and grasp leadership as the perquisite of the ownership of property. None of these methods alone is adequate for the needs of modern industry; most of them are out of harmony with the traditions of American civilization. In the search for a solution of the problem experience points us to no other institution so promising as the school. It is the most mobile and elastic of all our great institutions and is easily adapted to new purposes, while it is at the same time incomparably the most economical of our institutions in proportion to the work accomplished by it. We have never as a people been disappointed in the accomplishment of any educational task we have set the school to perform, and the school has not been obliged to withdraw from any task that has once been assigned to it.

Such being the conditions of the problem, the third reason why higher commercial education is making rapid headway at the present time lies in the response which institutions of higher education have made in this country to the demands upon them in this connection. This in itself is one of the most encouraging manifestations of a new and broader conception of the university as an institution whose functions are to gather in to itself and conserve all knowledge, to represent the interests of all classes of the community which supports it, and to be as broadly useful as is possible, consistent with true learning in the training of men for the various activities of life. This sentiment which characterizes the thought of university circles to-day, in contrast to a narrower and more exclusive ideal once dominant, was well expressed by President Nicholas Murray Butler, in his inaugural address at Columbia University. He said, "In these modern days the university is not apart from the activities of the world, but in them and of them. To fulfill its high calling the university must give, and give freely, to its students; to the world of learning and of scholarship; to the development of trade, commerce and industry; to the community in which it has its home, and to the state and nation whose foster child it is."

Not only will the community be benefited, but the universities will be benefited by every new avenue of usefulness opened for the school. Already our universities through their libraries and collections are made the custodians of the community's knowledge. To these centers should be gathered as much as possible of the data upon which may be ultimately built an adequate science of wealth production. Much of this knowledge now perishes unrecorded with the men whose life energy has been expended in assembling it. This is a great loss to the race. The world of business is, in a sense, a laboratory where are discovered the principles of industry and commerce. These discoveries

should in some way be systematically garnered and so treasured that the rising generation shall have access to them. Our universities also comprise an assemblage of men of expert knowledge who would, many of them, greatly profit by being brought into closer touch with the world of affairs about them. The advance of the university into the field of higher commercial education can only be made successful by devising means of bringing the university into closer contact with the industrial and commercial institutions of the country. This is desirable not only for the sake of keeping the learning of the university from becoming stagnant with antiquated knowledge and to permit the rendering of the most effective service, but is necessary to prevent any serious hiatus between the academic life of the student and his later business career. The task of those interested in the advancement of commercial education appears to be a two-fold one; to prepare the necessary course of instruction, and to obtain from the business community the close sympathy and cooperation essential to the achievement of any large success.

The course of instruction finally adopted will necessarily be framed to correspond with the ideal which is formed of the business man as a person of power and knowledge. In the forming of this ideal there is need of much discriminating observation. All will agree upon the need of honesty and dependability and a certain complement of attractive personal qualities, and tenacity of purpose, and fertility of resource, which is closely allied to it. There is required also executive ability, a most complex manifestation of the personality involving character as well as rapid mental processes and the power to subordinate detail and quickly choose the vital points of a matter. The business man has constant need of the power to judge men, and of retentiveness of memory, together with that healthful working together of all the powers of mind involved in good judgment or common sense. The question must be answered, How in the choice of these and other characteristics does the educational problem of the future business man differ from the education of the man who is to get ahead in other walks of life? So far as this problem of evoking the latent powers of mind and heart is concerned, more undoubtedly depends upon the environment of the student's life, the ideals held before him, the methods of teaching, and the care taken to cultivate his powers of initiative, than upon the specific things studied. It may be suspicioned that courses of higher commercial education which differ in no particular from other university courses, except in the choice of studies, are half-hearted attempts at the solution of a new problem the real difficulties of which are not appreciated.

Turning to the subject-matter composing the courses in higher commercial education, provided by some fifteen of our larger universities, we find the most prominent place among the studies designed to give

general culture occupied by history. The first place among studies calculated to give special training is given to economics, which explains the general principles underlying the present structure of economic society. This includes, besides systematic courses, studies in applied economics, statistics, money, banking and finance. Under the caption 'Commerce and Industry' may be grouped studies in the principles of commerce and the geography, materials, customs and usages of commerce and also detailed examination into the structure and processes of the extractive and manufacturing industries. Attention should be called to the at present very meagerly developed study of industrial organization, which has to do with the administrative relations existing within an individual business, especially if it be of large size, and with the methods of utilizing the resources of investors in financing new undertakings. A very important group are the applied sciences, including industrial chemistry, the application of physics to industry, economic geology, etc. Among other subjects generally included are the modern languages and commercial law, the latter covering not only the legal liabilities attending industrial acts, but the principles upon which the state interferes to regulate the competitive struggle. The successful conduct of such a program of study obviously involves the cooperation of several departments of a university; the humanities are represented in the history, economics and languages; the scientific department in the various courses of applied science; the law department in commercial law; while the studies in 'commerce and industry' provide a new group which serves as a central topic about which the others are arranged.

The university must not be expected to show its full effectiveness in the new field it has entered until a considerable amount of preliminary work has been done in the collecting and classifying of knowledge, the preparation of text-books and the adapting of methods of instruction to the nature of the new subjects taught. Higher commercial education does not aim to fit the individual for the immediate assumption of responsible commercial tasks any more than engineering schools fit young men to step at once to the position of engineer-in-chief. There is a body of detail connected with the operation of most businesses which can only be learned in practice. The university is aiming to train the youth to clear thinking and to equip him with a knowledge of the general principles upon which sound business practice rests, trusting that with such a preparation his later advancement will be such that the years of study will prove years well spent and that, in addition to a compensating financial return, life will contain a richer reward of the higher utilities and a larger sphere of usefulness, because of the early implanted love of truth.

EVOLUTION NOT THE ORIGIN OF SPECIES.

By O. F. COOK,
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IT is a misfortune frequently lamented that new truth, the most precious attainment of each generation, is also the most unwelcome. We do not hasten to sweep out our stock of laboriously collected ideas, even after the worthlessness of the assortment has been declared. This conservatism of vested intellectual interests not only postpones the utilization of the results of scientific inquiry, but it has an even worse effect when it impedes further investigation and warps our perception of facts.

The great obstacle in the popularization of the fundamental and obvious biological fact of evolution was the theological dogma of the separate creation of species, and toward the overthrow of this the arguments of Darwin and his immediate followers were, of necessity, directed. After four decades the debate upon the general question may be said to have closed. The thoughtful public believes that species were not made like cakes by the baker, but that the diversity of organic nature has been attained by gradual changes and transformations, a process commonly thought of as 'evolution.' As soon, however, as we pass into the field of biology proper, and seek to know the nature and causes of this process, all unanimity of opinion vanishes. The fact of evolution is no longer doubted, but biologists are still writing thousands of pages annually in support of the most diverse and contradictory interpretations of evolutionary phenomena.

In spite of the external simplicity of the idea, evolution affords extremely complex and elusive problems, and in addition to the inherent difficulty of these, discussion is still cumbered with the original terminology. Vast quantities of argumentation wasted in attempting to convince theologians that they did not know how species were made are already forgotten, but a more troublesome legacy remains, in that the words and ideas upon which attention became focused during that struggle still darken our views of biological problems.

Evolutionists, too intent on a practical explanation of the diversity of species, seized upon the idea that organisms become adapted to environment, and disregarded the more fundamental fact that species are not by nature stationary, but have an independent motion of their own. This oversight brought us the impossible task of explaining how external conditions produce evolutionary changes, and prevented the per-

ception that adaptations are due to external causes only as environment may influence the direction of the normal and necessary movement of the species.

That evolution is thus an active, universal and truly physiological process is not considered in current theories, largely because thought and language have continued to follow the bias of the original controversy in seeking in evolution an explanation of the origin of species and in expecting, conversely, that an explanation of the origin of species would also explain evolution. It is, therefore, a matter of literary as well as of scientific difficulty to present an alternative view, that the multiplication of species is in no proper sense a result of evolution, but is due to entirely distinct causes more often antagonistic than favorable to evolutionary progress.

Evolution versus Taxonomy.

The early evolutionists were all systematists deeply impressed by the vast complexity of organic nature, a sentiment which we may still indulge, since two centuries of labor have but made a beginning in the task of describing and assigning names to the millions of groups of organisms. Nevertheless, it is to be regretted that biological evolution was viewed and expounded so exclusively from the standpoint of the taxonomist, since his interests are greatly at variance with those of the evolutionist, and the confusion of the two distinct lines of investigation has done much to perpetuate the erroneous identification of the origin of species with the process of evolution.

The evolution best appreciated by the taxonomist is one which has produced species separable by definite and easily definable characters. He finds such species on islands and in other circumscribed regions and thereupon decides that isolation is an important evolutionary factor, failing at the same time to perceive that the 'constancy' which he ascribes to insular species is merely a uniformity made possible by the limited area of distribution, and hence often absent in species of more extensive range. Small segregations of individuals acquire uniformity of characters more promptly than if they were larger, and the sooner afford diagnostic differences of use to the systematist. This does not, however, decrease the probability that evolutionary change is slower in small groups than in those which the systematist abominates—large assemblages of individuals, offering great variety of characters, but without uniformity of combinations.

The systematist is prone to believe that there has been more evolution in a genus of ten definable species than in another occupying the same geographical region, but consisting of only one species. For the evolutionist, however, the segregation of the numerous species means that the conditions are less uniformly favorable for the subdivided

genus than for the other. Among fossil organisms, also, the more generalized the types the wider was the distribution, the separation of local genera and species following with less favorable circumstances or greater competition. Segregation multiplies species by separating groups of organic individuals, just as the ocean might form many islands from a partially submerged continent. Species are biological islands, but we do not go farther in biology than in geography by the discovery that islands must be isolated. Isolation permits evolutionary progress to be made on separate lines until the differences become of diagnostic utility to the systematist, but that isolation is responsible for the changes which bring about the divergence of characters is a deduction no more logical than that the differences between islands are due to the waters which separate them.

Too narrow zeal in the descriptive task has led many systematists to act on the assumption that the same amount of difference should everywhere receive the same systematic recognition, a method sometimes defended on the ground that all variations of form or structure indicate incipient species budding out from the parent stock, and sure to become separate groups like other now segregated types, a supposition quite unsupported by evidence. Far more rational and more secure would be the progress of systematic biology if recognition as species were limited to groups of individuals separate in nature, regard being given to the *completeness of segregation* rather than to the *amount of difference.*

It is to be admitted, of course, that when specimens from a new locality offer tangible differences from any previously known, the working systematist must describe and name them as representing new species. To crowd them into an old species by 'emending the description' or by calling them a 'variety' is to guess at an integration in advance of knowledge; while to refuse to unite 'species' which have been shown to belong to a continuous series in nature is to prefer technical fiction to biological reality. A coherent group of interbreeding individuals is the unit of evolutionary biology to which the term species finds its most proper application. The tendency of some systematists to refer also to intergrading, unsegregated subdivisions of such groups as 'species' shows how easily conventional taxonomic methods may obscure evolutionary distinctions.

Criteria of Specific Distinctness.

Species differ, of course, in the variability of their characters, but, other things being equal, the uniformity of the individuals of a species might be expressed by a ratio between the range and the facilities for interbreeding. A widespread species of sedentary animals or plants will become locally diversified; more frequent intercommunication per-

mits more uniform progress. A single species may have as great a variety of characters as a dozen related groups which have been segregated. Two species may be quite distinct and yet differ much less than the connected extremes of another. That a species differs in different parts of its range does not necessarily mean that a subdivision will take place; it means merely that characters are originating more rapidly than they spread over the whole species. The integrity of a species is not destroyed by 'inconstancy' of characters, but because geographical or other barriers make a gap in the series.

The failure of the extremes of a widely distributed species to breed when brought together does not prove the attainment of specific distinctness, nor the approach of it, since internal diversity does not weaken the species, but is an evolutionary advantage, and both extremes may continue to cross freely with the connecting forms, which constitute the bulk of the species. Neither does the power to form fertile hybrids prove that two species occupying distinct ranges are one. Faith in such criteria is simply a remnant of the pre-evolutionary theory of the separate creation of species. The only way to ascertain that two groups of organisms are separate species is to find the gap between them. Whether they will breed together or not, and whether the hybrids are fertile and vigorous, or weak, sterile and aberrant, may indicate the period and degree of divergence of the types crossed, but affords absolutely no evidence as to whether the series to which they belong in nature are continuous or interrupted. Specific distinctness is a question much more geographical than evolutionary. Evolution continues whether the species is divided or not; the divergence of the parts is rendered possible by the cessation of the interbreeding which would otherwise maintain the coherence and relative uniformity of the undivided group.

Segregation and Vital Motion.

The systematist 'separates' species because they are 'different,' but the evolutionary significance of species does not appear from formal descriptions of these biological islands; it lies in the fact that isolated groups of organic individuals universally acquire diagnostic differences. Isolation has furnished millions of these tests of the universality of biological motion, but it does not cause the motion. Evolution is independent of isolation, and without it has often brought about great diversity of form and structure, as witness the dissimilar sexes, castes, dimorphic and alternating generations of many species of plants and animals. Without evolutionary progress there would have been no species as we now know them, but the causes of the segregation of species are not causes of evolution; segregation merely permits this universal tendency to become more manifest. If it should be found that evolutionary divergences sometimes assist natural selection or

physical barriers in the work of subdividing species, this would mean that evolution sometimes results in segregation, not that segregation results in evolution.

Evolution is a process of change in species; it is the journey of which individual variations are steps. Evolution changes the characters of species, but it does not originate species.

Natural selection may assist geographical and other influences tending to the division of species, but it is not on that account a cause of evolution; it represents the determining aspect of the environment—the factors which influence the direction of the vital motion, but not those which induce the motion. Natural selection may explain differences between two species, but not the becoming different. It is an external incident or influence and not an active principle or agency of organic evolution. Adaptation is possible because there is a vital motion which can be deflected, not because the environment changes the characters of species. The river of evolution flows through the land of environment; the conformation of the valley determines the course of the stream, but the water descends by its own gravity.

In the course of its progress the species explores all the adjacent territory and follows the line of least resistance to the variations it is able to put forth. Changes are necessary to maintain the vitality of the species and also to keep it abreast of its environmental opportunities, and if no adaptive movement can be made it is still unable to remain stationary, but continues to change in characters indifferent to the environment, or even actually detrimental.

The species encounters obstacles and subdivides because it is in motion; the division takes place when variations can no longer spread freely among the individuals of the species, not because the environment introduces new characters.

That species occupy definite regions of distribution has been taken by some to mean that the individuals are similar because they are molded by similar influences, but that this inference is wrong is shown both by the wide diversity of conditions under which some species exist, and by the even wider diversity of form and structure often found among the members of the same species in the same environment. Similarity of conditions may permit plants and animals of different origins to develop similar variations, and to share, finally, the same adaptive characters, but identical conditions do not put an end to individual variations or to evolutionary progress.

The Function of Selection.

By denying that selection has any power to initiate or actuate developmental changes it is not intended to imply that it has not profoundly influenced the course of evolution in many organic groups.

Indeed, it may be claimed that the kinetic theory of evolution affords the first concrete explanation of the workings of natural selection. Vital motion not only makes selective influence possible, but it meets the ancient and hitherto fatal objection to the theory of selection, since it shows how characters may originate and develop to the point of utility or harmfulness, where selection can take effect.

The hypothesis of selection as the active principle or causal agency of evolution became illogical and useless as soon as the inheritance of acquired characters was abandoned. The first idea without the second does not account for adaptations. The 'selection' of Nägeli, Weismann and other believers in a 'determining principle' or 'hereditary mechanism' of evolution is a very weak substitute for the Darwinian idea, able only to eliminate the hopelessly unfit, but quite without means of influencing the survivors. The recognition of a continuous and necessary vital motion permits us to understand that the rejection by the environment of a harmful variation encourages adaptation by accelerating the development of any more adaptive variation which may appear.

All organisms are subject to selective influence in the sense that variations are rejected with a promptness proportional to their harmfulness in the given environment, but generally this leaves a very wide latitude of possible changes in which selection does not interfere. The instances are relatively rare in which existence becomes acutely dependent upon the development of some one characteristic or quality, and such narrow selection does not strengthen the type, but insures and even hastens its extinction.*

The Significance of Species.

The traditional illustration of organic descent by a tree with ever-dividing branches is entirely misleading as a suggestion of the nature of evolutionary processes, because individuals do not follow each other in simple series. Successive generations are connected by endless intergraftings of the lines of descent. A species may be treated systematically or statistically as an aggregation of individuals, and may be described by an averaging of the characters of these; but from an evolutionary point of view it does not exist as a species because of the possession of a certain complex of characters, but because the component individuals breed together; through this alone is the integrity or coherence of the species maintained. For evolutionary purposes we may think of the same species existing thousands of years hence,

* 'Stages of Vital Motion,' POPULAR SCIENCE MONTHLY, LXIII., 16, May, 1903.

and with any or all its characters changed.* It is not necessary even that the individuals of a species remain alike; in many unrelated natural groups extremely diverse sexes, castes and 'forms' remain associated in the same species and travel together on the evolutionary journey, sharing the same environment, but without any tendency to become 'exactly alike.' Moreover, we know that sexual and other diversities inside the species are not casual or accidental, but normal and advantageous, facts quite overlooked in static theories, which have viewed life from a narrowly systematic standpoint and have argued that interbreeding prevents the preservation of new characters and is thus a hindrance to evolution.

The kinetic theory, on the contrary, ascribes the fact that organisms are everywhere bound up into species to a property of fundamental evolutionary importance, and interprets the multitudinous devices for maintaining the coherence of groups of interbreeding organic individuals and the equally general manifestations of sexual and other diversification inside specific lines, as due to the same requirement of protoplasmic organization, an interlacing network of descent. Without cross-fertilization species would not cohere, but would split into numberless independent, diverging lines. This takes place with organisms long propagated asexually, whether artificially or in nature. For example, the genus *Sphagnum*, which very rarely produces spores, offers a multiplicity of varieties nowhere approached among mosses having normal sexual reproduction; but notwithstanding so many differences in minute details *Sphagnum* has remained a very compact, unprogressive group. Cross-fertilization prevents this type of diversification, but it need not on that account be supposed to impede evolutionary progress. Evolution is not merely a progressive diversification, it requires also a progressive synthesis of characters by the interbreeding of the individual members of specific groups.

The Species a Protoplasmic Network.

That sexual reproduction is a substitute or improvement of multiplication by fission is another partial and misleading view which has contributed much towards the concealment of the causes of evolution. The division of cells is the only method of organic increase; conjugation is not multiplication, but serves as a preliminary stimulant to the necessary cell-division. What is growth, for example, among the filamentous algæ composed of chains of cells is reproduction among the unicellular species, where divided cells become separate individuals.

*'Four Categories of Species,' *American Naturalist*, 33:287, April, 1899. The 'species' into which paleontologists arbitrarily divide geological series of organisms may be explainable by evolutionary progress alone, but the multiplication of the contemporaneous species of a given horizon is a different question.

Only among the simplest organisms, if anywhere, is indefinite reproduction possible without the assistance of conjugation.

The new science of cytology has made us aware that the division of cells is not a passive or a simple process, but is extremely active, complex and varied. Living protoplasm is in motion, and the discovery that cell walls are not hermetically closed, but are perforated by delicate protoplasmic strands, lends strength to the belief of some biologists that protoplasm circulates, not only inside the individual cells, but through the entire organism. Conjugation may signify that such a circulation extends also throughout the species. Or, to vary the analogy, the net-like structure of protoplasm may be thought of as continuous, not only in the individual, but as binding together the whole species by the intercrossing of the lines of individual descent. As individual organisms will in different degrees endure subdivision, and are able to restore or regenerate the lost part, so species may survive a certain amount of segregation, but if too small a group of individuals be cut off it perishes through the reproductive debility long recognized as inherent in inbred or narrowly segregated organisms. For taxonomy the tree notion of descent was sufficient as a means of indicating the history and affinities of species and higher groups, but evolution is a process which must be studied inside the species, and here the diagram of relationship is not dentritic, but reticular.

Symbasis a Cause of Evolution.

If reproduction by means of cell-division is reckoned as an essential property of protoplasm, equally fundamental importance can scarcely be denied to the property called symbasis* which requires this interweaving of numerous lines of descent and this simultaneous movement of organisms in specific groups. As organic complexity increases there is greater necessity for cross-breeding, as evidenced by the accentuation of sexual diversity, and by the decline of asexual propagation and of the power of regenerating lost parts. Organisms which have traveled farthest upon the evolutionary journey are most dependent upon symbasis. Nowhere among the higher animals, including many thousands of species of arthropods and vertebrates, is there known to be a long continued series of nonsexual individuals.† In comparison with the

* POPULAR SCIENCE MONTHLY, May, 1903. Symbasis may be defined further as the property of which sexual diversity and cross-fertilization furnish the phenomena. The word may also be used physiologically to signify a normal and advantageous range of interbreeding among the individuals of organic groups. It is to be distinguished on the one side from wide cross-breeding and on the other from narrow inbreeding, both of which produce inferior offspring and interfere with evolutionary progress.

† Among the bees fertilization may be omitted for a single male generation, and among the plant-lice for several wingless generations, but such instances are admittedly exceptional and specialized.

higher animals plants are but loose and unspecialized aggregations of cells, and yet among them also sexual differentiation has made great progress, and in some orders contrivances to insure cross-fertilization are highly developed.

The extent to which conjugation exists among the lower groups is not yet determined. That it may be omitted for many generations of a simple organism should not be taken to mean that it is entirely absent or has no importance, since among the higher animals, where cross-fertilization is recognized as indispensable, the growth of the body to maturity requires millions of cell-divisions, each of which would mean a new generation in a unicellular species. The supposed absence of sexual reproduction in certain parasitic and saprophytic groups is a confirmatory exception, in view of the obvious degeneration of such organisms.*

To the many speculations on the purpose of sex and cross-fertilization it can do no harm to add the conjecture that the presence of moderately diverse qualities of protoplasm facilitates cell-division. Some have held that the function of sex is to assist evolution by producing variations, and others that it neutralizes variation by maintaining a stable average. From the kinetic point of view it appears that symbasis, as represented by the phenomena of sex and of cross-fertilization, is not an impediment to evolution, nor a device to cause variation, but a means of communicating it. Variations appear without sex, and may even be accumulated, as by the adding of one bud variation to another in plants propagated by grafts or by cuttings, like the bread-fruit, apple and banana. Such progress is, however, slow and halting, and is accompanied by a decline in reproductive fertility. Symbasis not only sustains the vitality of organisms already evolved, but it is directly responsible for the upbuilding of the complex structure and vital economy of the higher plants and animals, and it builds the faster when by the differentiation of sexes two sets of variations can be accumulated.

To symbasis is due also the arrangement of organisms in the coherent groups called species, or what may be termed the specific constitution of life. Conjugation is the means of symbasis, as division is of reproduction. Sexual and other dimorphism, and the numerous specializations, devices and instincts by which cross-fertilization is secured, are aids to symbasis, just as the spore-sacs, ovaries and placentæ facilitate reproduction. The phenomena of reproduction and those of sym-

* There is also the possibility that they secure from their hosts protoplasmic compounds of high complexity which serve as a partial substitute for conjugation. It is further to be observed that under a kinetic theory the existence of sexual reproduction and cross-fertilization in many fungi in which these processes are still unknown may be inferred from the simple fact that the individuals are grouped into well defined species.

basis are combined, perhaps inextricably, but all attempts at assigning them to a single cause or property have failed.

Cross-fertilization is commonly misunderstood to be merely an accessory of reproduction, and a negative factor in evolution, because it is supposed to conduce to the permanence of the specific type by averaging away the new characters which arise as individual variations. There is the amplest experimental evidence that cross-breeding is necessary to maintain the quality and efficiency of the individual, but static theories* require us to believe that evolutionary progress requires conditions unfavorable to the individuals of which species are composed, since under such conditions selection is most effective, and abrupt variations are most striking and numerous. The alternative kinetic theory holds that cross-fertilization, as the active agency of symbasis, is a positive and primary factor of evolution, coordinate with variation itself. Symbasis is, as it were, the multiplier of the evolutionary equation, because it compels the distribution and combination of individual variations into the resultant vital motion of the species. Evolution no longer appears as an abnormal or exceptional phenomenon, and it becomes clear that the conditions under which the species is most prosperous are also those which permit the most rapid evolutionary progress.

The Prepotency of Variations.

The first corollary of the law of symbasis is the prepotency of variations. The combination of variations not only permits the structure of the organism to be strengthened and rendered more efficient, but also gives prepotency, due to the opportunity of vital motion. Variant individuals being thus both vigorous and prepotent, it is easy to understand why diversity, and not uniformity, is the tendency of normally extensive species; changes are necessary and welcome, and the perpetuation of them does not require segregation. Numerous and well authen-

*Static theories, under which species are held to be normally stationary, may be subdivided into two groups, those which look upon evolutionary progress as gradual and actuated or carried along by natural selection, and those which treat the motion as discontinuous or saltatory, and due, not to selection, but to abrupt variation or mutation. Selective theories, again, may hold either that the environment causes the desirable variations or 'acquired characters,' or they may imply the notion of a somewhat constant range of variability in species, which are thought of as growing out farther on one side because selection keeps them pared off on the other. Movement is thus ascribed variously to the direct action of the environment, to selective isolation, to abrupt transformation or mutation, or to some combination of these. The kinetic theory rejects all these supposed factors and interprets vital motion as continuous, gradual and self-caused, or inherent in the species, but the environment is thought of as influencing the direction of organic change. Selective influence is neglected altogether by still other theories, such as that of Naegeli, in which evolution is explained by an internal 'hereditary mechanism,' supposed to carry the species along in a definite direction.

ticated instances of distinctly prepotent variations are known, and such were taken by Mivart and other zoologists to prove that species do not originate by gradual change, but abruptly or by 'extraordinary births,' a view quite similar to the recently published 'Theory of Mutations,' but distinctly more practical because the 'mutations' of plants which are the basis of the inferences of Professor De Vries are not prepotent but 'recessive,' presumably because they do not represent true genetic variations, but are symptoms of what may be described as an evolutionary debility, due to inbreeding. The disappearance of mutative characters when the new variations are crossed with the parent form or with each other is merely the recovery, as it were, of the health of the species when the abnormal condition of inbreeding has been removed, as shown so conclusively in Darwin's well-known experiments with pigeons, and confirmed by an abundance of similar facts.

Though differently interpreted, many other facts supporting this view were collected by Darwin, who summarized the results of his studies of *Ipomea, Digitalis, Origanum, Viola, Bartonia, Canna* and the common cabbage and pea, as follows:

"The most important conclusion at which I have arrived is that the mere act of crossing by itself does no good. The good depends on the individuals which are crossed differing slightly in constitution, owing to their progenitors having been subjected during several generations to slightly different conditions, or to what we call in our ignorance spontaneous variations."*

Differences between the plants of different habitats mean also different lines of descent and attendant variations, and the beneficial results of bringing these together may be explained by reference to symbasis rather than to the 'slightly different conditions.'

While it may not be insisted that species, as described and named by systematists, are never originated by 'extraordinary births,' or from 'mutations,' both suppositions are obviously improbable as general explanations. Mutations are seldom fitted to survive because they are less vigorous and less fertile than the parent type, so that they must be segregated at once in order to be preserved. And even prepotent variations have no necessary connection with the origination of species, since however rapidly the characters of a species might change, it would still be the same species until a subdivision had taken place. The more a species evolves the more different from its relatives it becomes, and the more satisfactory for the purposes of systematic study, but this progressive transformation of the 'type' carries with it no necessity for subdivision, nor any indication that evolution is concerned with the origination of species.

* Darwin, 'The Effects of Cross and Self Fertilization in the Vegetable Kingdom,' p. 27. New York, 1895.

Summary.

Evolutionary study and thought have been hindered by the confusion of two unrelated biological phenomena, (1) evolutionary progress or vital motion, and (2) the origination or multiplication of species. The 'origin' of a species is not more evolutionary than any other stage in its history. The causes of the subdivision of species are not causes of vital motion; the two processes are quite distinct. The separation of two species is not a focus of the evolutionary problem; it is a mere incident of developmental history.

Segregation is the principle or active cause of the multiplication of species, but the nature and causes of evolutionary progress are not to be ascertained by discovering that species originate by subdivision. Vital motion is continuous, and is neither actuated nor interrupted by the segregation which multiplies species.

Natural selection may assist in the segregation of species, but it is not a factor in evolutionary progress, except as it influences the direction of vital motion. Specific groups become diverse when the component individuals no longer share their variations through interbreeding; not because new characters are induced by external influences. Evolutionary divergence may take place under identical conditions, and in characters which have no relation to the environment and no value to the organism except to permit the necessary vital motion.

A stationary heredity or the continued repetition of an identical structural type exists nowhere in nature; variation is an inherent evolutionary property. Segregation is not necessary for the preservation of variations; genetic variations are prepotent and are more rapidly propagated by crossing with the parent form.

A second evolutionary property of organisms is symbasis, which has built up the complex structure of the higher animals and plants by combining individuals into the interbreeding groups called species. The evolutionary species is not a complex of characters or a mere aggregation of similar plants or animals; it is a protoplasmic network held together by the interbreeding of the component individuals. Symbasis accelerates vital motion, but hinders the multiplication of species.

Species and evolution are different aspects of the same fact; evolution goes forward within specific lines as a manifestation of the same property which necessitates the existence of species; variation and cross-fertilization are not antagonistic phenomena, but two phases of the same creative process.

SOME HISTORICAL ASPECTS OF VEGETARIANISM.

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VEGETARIANISM, as the term is popularly understood at the present time, is a system of living which teaches that the food of man should be derived directly from the plant world. Considered in the light of its history, however, vegetarianism involves something more than a mere dietetic program. It teaches that the use of animal food is morally wrong, as well as erroneous with respect to the processes of nutrition. The modern critics of the vegetarian propaganda have frequently overlooked the fact that this doctrine has repeatedly, if not always, been the expression of an ethical movement among its expounders; and that its development and transformation ought to be considered with reference to sociological, economic and ethical conditions as well as from the standpoint of physiology.

The use of fruits and vegetables as the appropriate food of mankind has found its advocates from earliest times. Pythagoras (500 B. C.) in particular has frequently been pointed out as the most eminent teacher of vegetarianism among the ancients. It is obvious that a philosophy of life which urged men to lead modest lives, to abstain from indulgences of various kinds, and to seek simplicity in every form, might readily and naturally proclaim the desirability of a simple diet. Abstemiousness in the use of food and asceticism in matters of conduct and religion were brought forth by the same attitude toward the problems of the world, and found expression in vegetarianism as a simple mode of nutrition. For the vegetable foods are as a rule easy to obtain and prepare for dietetic purposes. The praise which the earlier moralists bestowed upon the vegetarian diet and mode of living is merely an aspect of the reaction against the excesses of the period. In Rousseau's 'Return to Nature' likewise we find the advocacy of a simple vegetable diet incidental to the proposed change to primitive conditions of living and the striving for moderation in every feature of society. And even to-day vegetarianism is defended by arguments derived from purely ethical and religious, as well as from economic or hygienic considerations. This peculiar sentiment which defends and prescribes the exclusive use of vegetable foods in the struggle against immorality and the attempt to establish a more virtuous community is expressed by Tolstoi in words illustrating how

extensively non-physiological considerations are still drawn upon in justifying vegetarianism. He writes: "The individual who endeavors to exercise abstemiousness will unavoidably be obliged to abide by a fixed rule, the first element in which is abstemiousness in eating—fasting. But if he fasts and strives earnestly and zealously to lead a good life, he must, above all things, abstain from animal foods. For aside from the incitement of the passions which is provoked by these foods, it is decidedly improper to partake of them for the reason that they call for a procedure which is revolting to our moral feelings, namely, the act of putting to death."*

It has frequently been pointed out that the apostles of the non-animal diet have been individuals imbued with unusual views of life and the ways of the world. As in earliest times religious motives were the underlying factors in the prescription of rules of living, so in subsequent periods it has usually been some idealistic conception of the problems of existence which determined the vegetarian doctrine of the time. The political dreamer and the philosophical visionary represent types of men in whom the striving for a new order of doing found expression. No period of history has lacked individuals who fail to find in existing systems the Utopia of their dreams. The traits of mind here referred to are exemplified in the poets Byron and Shelley, both of whom the vegetarians have been proud and eager to include within their ranks. It is needless to refer to the eccentricities or the remarkable genius of either. It is well known of the one that his morbid disposition was not infrequently roused and irritated; of the other it has been said that 'his imagination preponderated over judgment and reason.' Some light is perhaps thrown upon the real attitude of the poet in the subject under discussion by the following lines from Shelley's 'Queen Mab' (VIII.):

> Here now the human being stands adorning
> This loveliest earth, with taintless body and mind;
> Blest from his birth with all bland impulses,
> Which gently in his bosom wake
> All kindly passions and all pure desires.
> . . . . . .
> And man, once fleeting o'er the transient scene
> Swift as an unremembered vision, stands
> Immortal upon earth. No longer now
> He slays the lamb that looks him in the face,
> And horribly devours his mangled flesh,
> Which still avenging nature's broken law,
> Kindled all putrid humours in his frame,
> All evil passions, and all vain belief,
> Hatred, despair, and loathing in his mind,

* Tolstoi: 'Die erste Stufe,' 1892, quoted from Albu: 'Die vegetarische Diät,' 1902.

The germs of misery, death, disease and crime.
No longer now the winged habitants,
That in the woods their sweet lives sing away,
Flee from the form of man, . . .
. . . . . .
All things are void of terror; man has lost
His terrible prerogative, and stands
An equal amidst equals. Happiness
And science dawn though late upon the earth;
Peace cheers the mind, health renovates the frame.

Lord Byron evidently believed that flesh eating excites men to war and bloodshed; thus he testifies in 'Don Juan' (Canto II.):

That Pasiphae promoted breeding cattle,
To make the Cretans bloodier in battle.

For we all know that English people are
Fed upon beef—I won't say much of beer
Because 'tis liquor only, and being far
From this my subject, has no business here:
We know, too, they are very fond of war,
A pleasure—like all pleasures—rather dear;
So were the Cretans—from which I infer,
That beef and battles both were owing to her.

The beginning of the modern vegetarian movement is usually dated from the publication of an essay entitled: 'Return to nature, or defence of vegetable régime,' by I. Newton (London, 1811). To the influence of this, the formation of the first vegetarian society by Joseph Simpson in Manchester, England, in 1847, is ascribed; and so far as I am aware the word vegetarian was coined at this time. A similar society is reported to have been formed in the United States in 1850. The use of a vegetable diet had, however, been advocated and practised over a century before, as the following extract from Benjamin Franklin's autobiography testifies. Referring to about the year 1722 he said:

When about sixteen years of age, I happened to meet with a book, written by one Tryon, recommending a vegetable diet. I determined to go into it. My brother, being yet unmarried, did not keep house, but boarded himself and his apprentices in another family. My refusing to eat flesh occasioned an inconvenience, and I was frequently chid for my singularity. I made myself acquainted with Tryon's manner of preparing some of his dishes, such as boiling potatoes or rice, making hasty-pudding and a few others, and then proposed to my brother, that if he would give me weekly half the money he paid for my board, I would board myself. He instantly agreed to it, and I presently found that I could save half what he paid me. This was an additional fund for buying of books; but I had another advantage in it. My brother and the rest going from the printing house to their meals, I remained there alone, and, dispatching presently my light repast (which was often no more than a biscuit, or a slice of bread, a handful of raisins, or a tart from the pastry cook's, and a glass of water), had the rest of the time till their return for study; in which I made the greater progress from that greater clearness of head and quicker apprehension, which generally attend temperance in eating and drink-

ing. Now it was, that, being on some occasion made ashamed of my ignorance in figures, which I had twice failed learning when at school, I took Crocker's book on Arithmetic, and went through the whole by myself with the greatest ease. (Sparks's 'Life of Franklin,' p. 19).

The early literature of the vegetarian movement in this country indicates a greater tendency toward the substitution of arguments based on scientific observation in place of purely sentimental considerations than do the trans-Atlantic publications of similar date. It must not be inferred from this statement, however, that visionary and unscientific doctrines were wanting. Evidence to the contrary is readily available. In 1833 the Boylston Medical Committee of Harvard University offered a prize for the best dissertation on the following question: 'What diet can be selected which will ensure the greatest probable health and strength to the laborer in the climate of New England? quantity and quality, and the time and manner of taking it, to be considered.' The prize was awarded to Dr. Luther V. Bell, whose essay (1836) may still be read with interest. The status of the propaganda against flesh-eating as summarized by him is quoted here, since it indicates how similar have been the personal characteristics and motives of the vegetarian advocates in the most widely separated localities. Bell wrote:

Some extraordinary, and to the unprofessional class, doubtless novel, views in regard to diet were broached and have since been pressed upon attention, and that too by at least some men of scientific reputation, ingenious lecturers and individuals who from weight of personal character, or their position before the public, possess no limited influence. They have persuaded themselves, and labored hard to proselyte to their own faith, that the use of animal food in all its forms and varieties, is a custom, unnatural, injurious to bodily health, and even prejudicial to intellectual and moral sanity;—a custom at once unnecessary and inexpedient. How far, or how durably, they may have impressed the public with their views, time only can show; at present it need only be said, that such effect has at least been produced, as to raise a laudable curiosity and wish for the truth, in the minds of many, deserving to be gratified.

Bell adds the following interesting remarks:

Their views are by no means new or original. They date their origin at least as far back as the ancients, and they have been received in every century from the time of Pythagoras to the days of the philosopher of Geneva (Rousseau). "It is not intended to deny the right of ingenious men to propose innovations, and it is a fortunate circumstance that the public is as much too slow in coming into a practical acknowledgment of new truths, as men of erratic and visionary genius are too sanguine in promulgating and inculcating new hypotheses. It is dangerous to unsettle long established truth, for it is difficult to limit the extent of error. The gratification of a morbid desire to be distinguished as the propagator of new principles in philosophy, or as the head of a new sect, is not the only result to be expected from such heresies. New opinions or doctrines, whether true or false, will have admirers and followers, and will lead to practical results, and the errors of one man may lead thousands into the same vortex." (Bell, 'A dissertation on the Boylston prize question for 1835,' pp. 6–7.)

The conclusions to which Bell's study led him are worthy of brief mention. He summarized as follows:

1. A diet of *both* animal and vegetable food is adapted to the condition of the New England laborer.

2. No grand errors exist in his present system of diet, and no radical change is demanded to ensure a greater amount of health and strength, though many minor, but still important errors exist.

3. The proportion of animal food usually customary is too great, and a considerable reduction would be expedient and advantageous, though it is impracticable to make a precise statement of the extent to which this is required, which must depend upon circumstances, as amount of labor performed, climate, season, bodily constitution, habits of life, etc. A general statement of this fact can alone be made.

4. The amount of food in general, customarily used, is more than is necessary for the maximum of health and strength, though a more specific statement of this abuse is also impossible. It must be left for each individual to attempt to reduce his quantity of food to that point at which he finds his mental and bodily powers most energetic. In searching for this point the New Englander may be almost certain that he must look for it in descending ratio.

5. The great principle in regulating diet is to regard quantity rather than kind.

Most students of dietetics will, I think, readily admit the validity of the majority of these statements, even in their application at the present day. In contrasting the conditions during colonial days with those prevailing in our own times it is entertaining, if nothing more, to recall some ideas regarding the diet of the people of the United States at the end of the eighteenth century which were published by the French traveler Volney.* A grain of truth may doubtless be gathered from his vivid observations, even though they can not be taken too seriously. Thus he writes:

I will venture to say that if a prize were proposed for the scheme of a regimen most calculated to injure the stomach, the teeth, and the health in general, no better could be invented than that of Americans. In the morning at breakfast, they deluge their stomach with a quart of hot water, impregnated with tea, or slightly so with coffee; that is, mere colored water, and they swallow, almost without chewing, hot bread, half baked toast soaked in butter, cheese of the fattest kind, slices of salt or hung beef, ham, etc., all of which are nearly insoluble. At dinner, they have boiled pastes under the name of puddings, and the fattest are esteemed the most delicious; all their sauces, even for roasted beef, are melted butter; their turnips and potatoes swim in lard, butter or fat; under the name of pie or pumpkin (pumpkin pie?) their pastry is nothing but a greasy paste, never sufficiently baked; to digest these substances they take tea almost instantly after dinner, making it so strong that it is absolutely bitter to the taste, in which state it affects the nerves so powerfully that even the English find it brings on more obstinate restlessness than coffee. Supper again introduces salt meats or oysters: as Chastelux says, the whole day passes in heaping indigestions on one another; and to give tone to the poor relaxed and wearied stomach, they drink Madeira rum, French

* 'View of the climate and soil of the U. S. of America,' by C. F. Volney.

brandy, gin or malt spirits, which complete the ruin of the nervous system. (Quoted by Bell, pp. 23–24.)

The vegetable diet found an enthusiastic champion in America in the person of Dr. W. A. Alcott, who published a small volume on the subject in 1838. In the preface he tells us: "When I commenced putting together the materials of this little treatise on diet it was my intention simply to show the SAFETY of a vegetable and fruit diet, both for those who are afflicted with many forms of chronic disease, and for the healthy. But I soon became convinced that I ought to go farther, and prove its SUPERIORITY over every other." This the author attempted to do by an appeal to contemporary medical men and by a compilation of the 'anatomical, the physiological, the medical, the political, the economical, the experimental and the moral arguments' then prevalent. But the individual who probably did more than any other in this country to reduce the subject of vegetable dietetics to a system was Sylvester Graham. This eccentric reformer, remembered to-day in connection with the bread which familiarly bears his name, was an enthusiastic temperance advocate, who insisted that the craving for drink can only be combated by the use of a judicious diet in connection with correct habits of living. His belief that 'an exclusively farinaceous and fruit diet is best adapted to the development and improvement of all powers of body, mind and soul' was set forth for many years both in public lectures and in writings, among which the 'Graham Lectures on the Science of Human Life' (2 vols., 1839) were perhaps most widely quoted in vegetarian literature. About 1837 there was formed an American Physiological Society of two hundred members, nearly all of whom, as well as their families, abstained from animal food. (Cf. Alcott, 'Vegetable Diet,' p. 219.)

The characteristic features of the vegetarian movement in England are set forth in the 'Constitution of the Vegetarian Society of Manchester,' to which reference has already been made. The objects were:

To induce habits of Abstinence from the Flesh of Animals as Food, by the dissemination of information upon the subject, by means of tracts, essays and lectures, proving the many advantages of a physical, intellectual and moral character, resulting from *Vegetarian habits of Diet;* and thus, to secure, through the association, example and efforts of its members, the adoption of a principle which will tend essentially to true civilization, to universal brotherhood, and to the increase of human happiness generally.

As early as 1829 there existed in England a 'Society of Bible Christians,' of which a member wrote as follows:

The Society of Bible Christians abstain from animal food, not only in obedience to the Divine command, but because it is an observance which, if more generally adopted, would prevent much cruelty, luxury and disease, besides many other evils which cause misery in Society. It would be productive of much good, by promoting health, long life, and happiness, and thus be a

most effectual means of reforming mankind. It would entirely abolish that greatest of curses, *war;* for those who are so conscientious as not to kill animals, will never murder human beings. On all these accounts the system can not be too much recommended. The practice of abstaining can not be wrong; it must therefore be some consolation to be on the side of duty. If we err, we err on the sure side: it is innocent; it is infinitely better authorized and more nearly associated with religion, virtue and humanity than the contrary practice. (Cf. Alcott, pp. 214–215.)

One more quotation must suffice to indicate the spirit of the early modern vegetarian literature. Its author was J. A. Gleïzès, an eccentric writer of several volumes, who became a favorite of the Vegetarian Society. In the preface to 'Thalysie, ou la nouvelle existence' (3 vols., 1840–1842) he wrote:

Je me propose d'y démonstrer:

1°. Que l'homme n'est point animal de proie; qu'il est, au contraire, par sa nature, la plus douce de toutes les créatures, ainsi que devait l'être la dernière et la plus noble expression d'un Dieu grand, bon et juste.

2°. Que le meurtre des animaux est la principale source de ses erreurs et de ses crimes, comme l'usage de se nourrir de leur chair est la cause prochaine de sa laideur, de ses maladies, et de la court durée de son existence.

3°. Que cet état d'égarement est dans une opposition directe avec sa destinée ultérieure dans le sens communément attaché à ce mot, autrement dit, la vie hors de la terre; tandis que la privation de cet acte, ou, pour parler positif, le régime des herbes, développe en lui la beauté l'intelligence, la vertu, et le fruit immortel qui en est le dernier résultat.

It is unnecessary to multiply examples in order to emphasize how diverse have been the actuating impulses of the vegetarians of history. Like England and America, Germany has had its vegetarian movement which developed particularly under the leadership of Ed. Baltzer. The first German vegetarian society was founded by him in 1869. Here, as elsewhere, the system proposed has never received broad recognition among the masses of the people, but has rather been confined to small bands of enthusiasts. Even among the latter there is no unanimity of plan. The most radical reformers have abstained not alone from all food of animal origin, but also from tubers and underground roots, eating only fruits and vegetables grown in the sunlight; others again reject the cereals and live on fruits, nuts and milk; while the most conservative exclude only fish, flesh and fowl from their diet. Among the latter groups may be arranged the so-called fruitarians who abstain from all food obtained by infliction of pain. The student of the psychology of the vegetarian faith can not fail to be impressed by the diversity of the elements which have convinced its expounders. Physiological and anatomical arguments based on the comparative structure and functions of the digestive organs have vied with considerations of economy, morality and religion. From the standpoint of hygiene, the dangers of disease lurking in animal flesh have been pointed out; to other persons the encouragement of horticulture and the racial im-

provement incidental to an active agricultural life have offered an attractive theme. The vegetable kingdom can satisfy all. "If any vegetarians be extravagant in milk and eggs, it is not from any craving of their stomachs, but from excess in zeal or ignorance in their cooks." (Newman, *Frazer's Magazine,* February, 1875.) Finally the Bible itself has been drawn upon to furnish lasting proof: "Behold, I have given you every herb bearing seed, which is upon the face of all the earth, and every tree, in the which is the fruit of a tree yielding seed; to you it shall be for meat." (Genesis, i., 29.)

The advocates of the vegetarian diet at the present day are no less ready to draw upon the diverse types of argument already discussed than were their predecessors of fifty years ago. In a recent volume, entitled 'The Living Temple' (1903), Dr. J. H. Kellogg, urging the use of non-meat diet, has presented the ethics of flesh-eating in the following light:

> The basis for the ethical argument against flesh-eating is to be found in the fact that the lower animals are, in common with man, sentient creatures. We have somehow become accustomed to think of our inferior brethren, the members of the lower orders of the animal kingdom, as things; . . . We are wrong in this; they are not things, but *beings*. . . . A horse or a cow can learn, remember, love, hate, mourn, rejoice, and suffer, as human beings do. Its sphere of life is certainly not so great as man's, but life is not the less real and not the less precious to it; and the fact that the quadruped has little is not a good and sufficient reason why the biped, who has much, should deprive his brother of the little that he hath. For the most part it must be said that the lower animals have adhered far more closely to the divine order established for them than has man.
>
> The divine order, as clearly shown by nature as well as by revelation, and by the traditions of the ancient world, and illustrated by the present practice of a great part of the human race makes the vegetable world the means of gathering and storing energy and making it into forms usable by the sentient beings that compose the animal world, the one gathering and storing that the other may expend. When animal eats vegetable, there is no pain, no sorrow, no sadness, no robbery, no deprivation of happiness. No eyes forever shut to the sunlight they were made to see, no ears closed to the sweet melodies they were made to hear, no simple delights denied to the beings that God made to enjoy life—the same life that He gave to his human children. (Pp. 184–185.)

On the other hand, we may recall Robert Louis Stevenson's apparent defense of cannibalism among some of the peoples inhabiting the South Sea Islands. He writes:

> How shall we account for the universality of the practice over so vast an area, among people of such varying civilization, and, with whatever intermixture, of such different blood? What circumstance is common to them all, but that they lived on islands destitute, or very nearly so, of animal food? I can never find it in my appetite that man was meant to live on vegetables only. When our stores ran low among the islands, I grew too weary for the recurrent day when economy allowed us to open another tin of miserable mutton. And in at least one ocean language, a particular word denotes that a man is

'hungry for fish,' having reached that stage when vegetables can no longer satisfy, and his soul, like those of the Hebrews in the desert, begins to lust after the flesh-pots. ('In the South Seas,' Chapter XI.)

How differently the experiences of mankind appeal to different individuals! We oppress the living, yet shrink from barbarities toward the dead; we condemn in others the very practises which at times have applied to ourselves. Individual bias is so common among the great masses of people that it is rare to find impersonal judgments in things ethical or religious. But ideas which claim exemption from scientific control can never demand recognition by force of argument alone. 'There is no short cut to truth except through the gateway of scientific method.' The doctrines of the vegetarians have not escaped the attacks of scientific criticism; with what success they have met, this paper is not intended to proclaim. It has aimed merely to point out some little known historical aspects of a movement which is unique, if not progressive. A position so long and stubbornly held can not be entirely devoid of some resources, and may well offer an occasional helpful suggestion for the improvement of our plans of nutrition. By the physician and hygienist especially is real progress in dietetics to be welcomed. *Qui bene nutruit, optime medebitur.*

TOKYO TEIKOKU DAIGAKU (IMPERIAL UNIVERSITY OF TOKYO).

By NAOHIDÉ YATSU, RIGAKUSHI,
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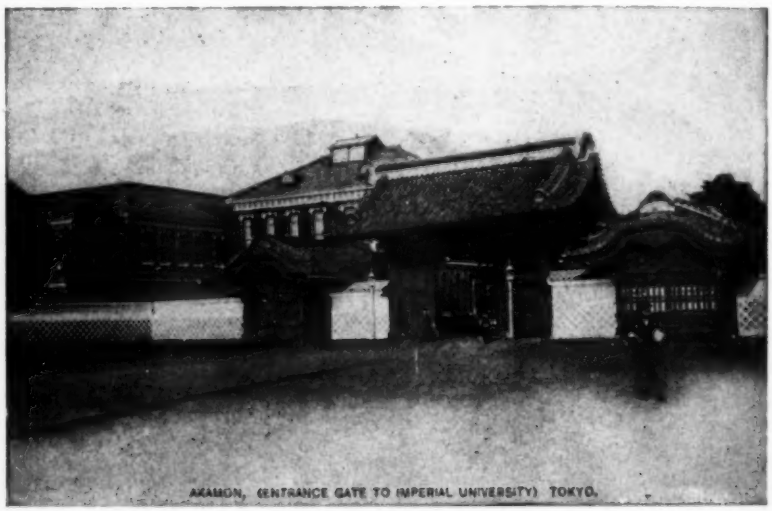
IN the recent outburst of literature upon Japan and things Japanese, one can not help feeling as he surveys the field that the European has but a scanty idea of the opportunities which the young Japanese enjoys for securing a thorough grounding in the learning of western nations. The average American or European is apt to think, that, aside from military and naval matters, the Japanese education of to-day is largely, if not exclusively, an Asiatic one. It may, therefore, be of interest to refer to the organization of the higher education



AKAMON, (ENTRANCE GATE TO IMPERIAL UNIVERSITY) TOKYO.

in Japan as it is being carried out at the present day. In this connection, I think, I may safely say that few foreigners realize the anxious care with which during the past score of years the emperor and his advisers have established the higher education of Japan on a basis as broad as that of the European universities, and at the same time, have aimed to mold in it the best elements of learning of both the west and east. And if this is not understood, still fewer foreigners realize, I think, the extent and character of the less modern form of education in Japan. Indeed, on the other hand, according to some recent writer, one might even fancy that Japan had no true learning before the ad-

vent of the 'black ships' of Commodore Perry. It may be of interest, therefore, to some, to learn that in so remote a time as in the eighth century a university had already been established in Japan that included such modern divisions as schools of medicine, ethics, mathematics, history, and that some of the text-books employed at that remote period dealt with such subjects as the diseases of women, *materia*

GROUND PLAN OF THE UNIVERSITY.

medica and veterinary surgery, types of text-books which appear to have been unknown in European countries until about one thousand years later.

Japanese higher education at the present day includes: (1) *high schools,* of somewhat higher scope than the American high schools, (2) *higher normal schools* for both sexes, (3) *colleges of peers and peeresses,* (4) *military and naval colleges* at Tokyo and Etajima, (5) a series of *schools of technology and arts,* including an *academy of music,* (6) *colleges of law, politics and literature* in Tokyo and Kyoto, (7) *girls' university of Tokyo* and (8) *Imperial Universities* of Tokyo and of Kyoto.

As the universities stand at the head of the educational system of Japan, it may be well to describe their organization in some detail. And I shall refer especially to the Tokyo Imperial University since the second one is only recently founded (1897).

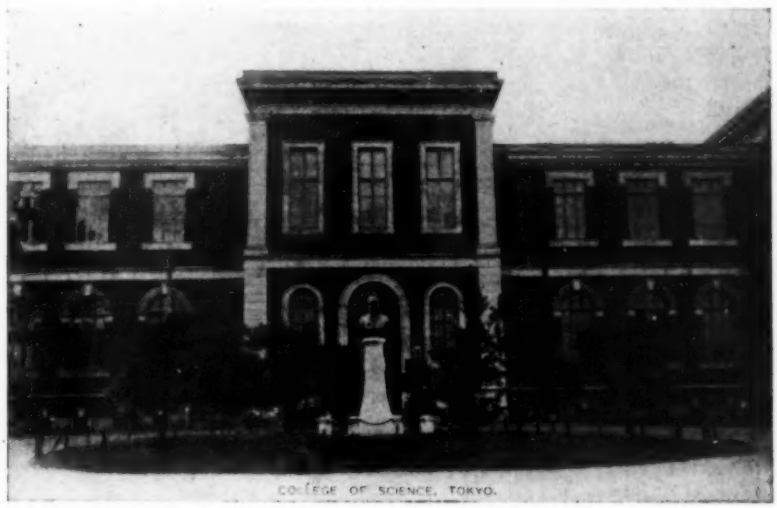
The university is strictly governmental and is under the control of the Department of Education, one of the main divisions of the imperial administration. It includes six colleges—law, medicine, engineering, literature, science and agriculture. In general, its students are the graduates of high schools and are enrolled in a three-year course, medicine and law requiring, however, four years. It may be safely said that the grade of the regular work of the university is higher than that of the American colleges, for I find that the courses which are set down in the curricula of many colleges for freshmen and sophomore classes are given in the Japanese high school. One may further note that in the interest of general higher education the university courses are practically free. And as evidence of the democracy of learning one may sometimes note a young noble sitting shoulder to

COLLEGES OF LAW & LITERATURE, TOKYO.

shoulder with the son of a peasant. It goes almost without saying that every university student is expected to understand lectures when given in one of the European languages.

With this introduction we may briefly refer to the development of our university. Between the end of the sixteenth century and the beginning of the eighteenth century young Japanese who had been thirsting for western learning began their study of medicine, astronomy, physics, chemistry, gunnery, fortification, by the aid of textbooks, mainly written in Dutch, which they had obtained, often in spite of much local disfavor, from the trading station at Nagasaki. Succeeding in their western studies, some of these Japanese workers opened schools at several places for the dissemination of their hard-earned knowledge. And one of these schools, named *Bansho-shirabejo* (the place for the examination of the writings of the barbarians).

was the embryo of our university. After the Restoration of 1868 this school, through many changes, became *Kaisei-gakko*. And to this was later added the medical college (1877), the law college (1885) and the college of engineering (1886). It was not, however, until March 1, 1886, that the university came actually into existence, a day which has come to be celebrated every year as 'foundation day.' In 1884–85 the colleges moved to their present site. To this end the university was ceded a park, three square miles in extent, located on a side of Hongo hill, in the northwestern part of Tokyo. The site, moreover, was of considerable historic interest, since it was the Kaga-Yashiki, or the palace grounds of Kagasama, one of the most powerful daimyos of feudal days, whose imposing processions of two-sworded retainers,

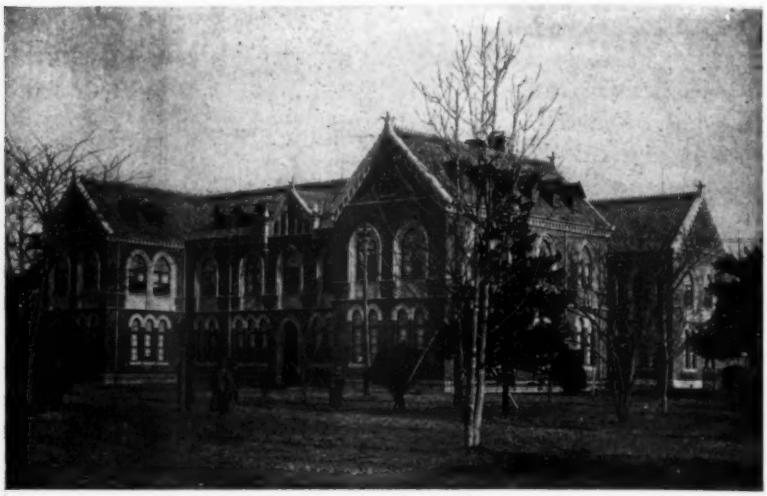


INSTITUTES OF PHYSICS AND CHEMISTRY.

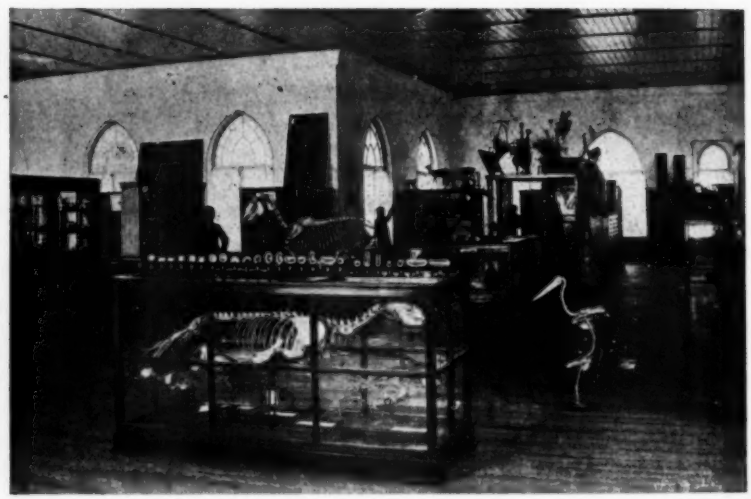
gold-laquered palanquins, and splendid horses are remembered to the present day. Indeed, the present red gate of the university is a relic of his feudal sway, his wedding gift, it is said, from the Prince of Satsuma. In contrast with former pageants one sees here to-day only a stream of students plain in uniform and with square caps, hurrying to and fro among the lecture halls. When the colleges first moved to the present site, wooden buildings were used for lecture-room and laboratories. But as time passed these were replaced by the brick buildings, which are shown in the adjacent pictures. The college of agriculture is situated in a suburb six miles away from the university. The Botanical Institute is in the Botanical Garden, situated in another daimyo's park, about a mile and a half away from the university.

The entire staff of the six colleges numbers about 270, of these 120

hold the rank of professor. It is significant of the progress of the Japanese in western learning that even in special branches of work few foreign instructors are now required. In earlier days the majority of the professors were foreigners, to-day their number has been reduced



INSTITUTES OF ZOOLOGY AND GEOLOGY.



INTERIOR OF THE ZOOLOGICAL MUSEUM.

to fourteen, and this number bids fair to be reduced as soon as able graduates return from their foreign studies to take their places. It follows, accordingly, that lectures are more and more frequently given in the Japanese language. It may be noted that in the science college there remain no foreign professors.

The present catalogue shows an enrolment of 3,121 students, and of these about 350 are post-graduates in the 'University Hall.' Every student must wear a square cap with golden badge of the university. And the 'square caps,' as they are called, are entitled to special consideration from the general public. The graduates are termed 'Gakushi,' to which title is added the prefix of their college, as Ho-

gakushi (law), Bun-gakushi (literature), I-gakushi (medicine), Ri-gakushi (science), etc.

The title 'Hakushi,' corresponding somewhat with Ph.D., is given to those who have been in the 'University Hall' (post-graduate) and passed prescribed examination, or to those who have attained similar distinction, especially in research.

The commencement usually takes place on July 11. It may be of interest to describe the ceremony, since it differs somewhat from that of American colleges. The large reading hall of the library is simply decorated; purple and white silk drape the walls, and in the place of honor hang portraits of the emperor and empress. The room is closely filled, students standing massed in military order in the middle of the room, professors and guests standing at the sides. Then the ceremony commences by the president's recital of the words of the emperor on the principles of ethics and on the education of his subjects. Then follows a brief address by the emperor, or by one of the imperial family. And after this has been made the emperor's gracious presents, about twenty in all, are given to the best graduates. Then the president gives an address. The national anthem 'kimigayo' is then sung three times, followed by the cries of 'Tokyo-Teikoku Daigaku Banzai.' The entire ceremony is a simple one, but it is notably solemn and impressive.

Even athletics are not wanting in this eastern university. The athletic club consists of seven sections—rowing, track athletics, baseball, football, lawn tennis, swimming, Judo (a kind of wrestling), fencing and archery. In the spring, when the rosy cloud of cherry blossoms covers the bank of the River Sumida, the rowing club holds a regatta. In the autumn the athletic section holds a meeting in the recreation ground of the university. Running, jumping, hurdle races, etc., last the whole afternoon, and the scene is as animated as even a Yale-Princeton 'rooter' could wish; the sloping hillside of the arena-like ground is filled with cheering crowds, and the mingling of costumes, colors and gestures add to the animation of the scene. In the matter of supplemental athletics, we may note that swimming is given a conspicuous place; a teacher even takes volunteer students under his charge during the summer vacation.

As a special development in the research work of the university one might briefly mention the laboratory for the study of earthquakes, which occur so frequently, and often, indeed, with dangerous results. And it was with the aim of studying these phenomena, from standpoints both of applied and of pure science, that the seismological observatory was founded in 1880. It has since been in charge of Professors Sekiya and Omoiri. In fact it is due to the researches of these scientists that the horizontal pendulum and the vertical motion seismographs were designed. By means of these delicate instruments it is possible to measure earthquakes and other earth movements of different grades of magnitude, ranging from microscopic tremors and pulsations up to destructive earthquakes. The instruments are so sensitive that an earthquake in England can be recorded in Japan, and from this the rate of traveling of seismic waves has been calculated. There has also been set up recently a horizontal pendulum for continuous registrations. These are an interesting collection, showing the development of seismographs from crude Chinese devices to the most elaborate and modern apparatus.

In the zoological museum there are the splendid collections of the glassy sponges. Hundreds of valuable specimens have been collected through Professor Ijima's constant and earnest exploration of the Sagami Bay. They are so fragile that they might easily be crumbled into pieces by the fisherman's rough hands. One may easily conceive how still is the abyss of 200 fathoms. The first two parts of beautiful monographs have come from the hands of Professor Ijima, who has been working on these delicate creatures for over ten years. Besides this collection, there are hundreds of curious creatures peculiar to Japan, rare specimens which arouse the enthusiasm and possibly even the envy of our foreign confrères. Indeed, every year forms which are new to science come to the museum. In connection with the sci-

ence college, I should also mention a marine biological station at Misaki. At this point, about thirty miles south of Tokyo, the warm 'black current' comes frequently close to the land and brings to the station interesting pelagic forms, especially the minute floating 'plankton.'

In anthropological lines Professor Tsuboi and his assistant have been many years engaging in the study of the Japanese races, past and present, including the exploration of Ainu, Formosan aborigines and the investigations of the prehistoric Japanese race. And in connection with his laboratory we may mention the rich anthropological cabinet.

In summary, accordingly, I think that it can safely be claimed that Japan has made studies not less in higher education than in matters of military, naval or practical importance, and that its work is progressing satisfactorily in quantity, no less than in quality. The Tokyo Imperial University, as we have seen, is not more than twenty-five years old, yet it has become the largest educational institution of the far east. Its graduates already number about 6,000, and of these alumni many are now filling posts of importance as professors, scientists, jurists, physicians, statesmen, diplomats, and one can predict with reasonable certainty that many of the best supporters of the future Greater Nippon and its emperor will have worn the square cap as they passed under the red gate of our alma mater.

THE PROGRESS OF SCIENCE.

IMMANUEL KANT.

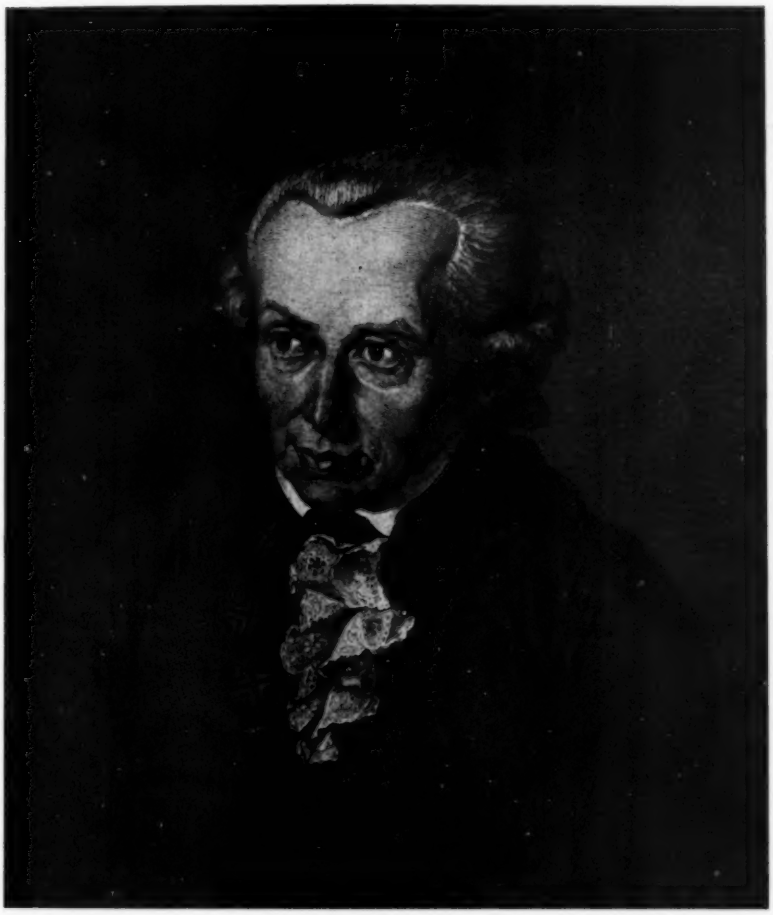
THE centenary of the death of Kant was commemorated on February 12. There was a special celebration at Königsberg, where the philosopher spent his whole life; a monument is planned for Berlin, and a Kant Society has been formed in Germany. It would probably be difficult for most readers of a scientific journal to explain why Kant is one of the great men of the world, and next to Aristotle the most honored philosopher. In the preface to his 'Kritik der reinen Vernunft' Kant expressed his own view of the service he hoped to accomplish in the following words: "In metaphysical speculation it has always been assumed that all our knowledge must conform to objects; but all attempts from this point of view to extend our knowledge of objects *a priori* by means of conception have ended in failure. It is well to ask, therefore, whether greater progress may not be made by supposing that objects must conform to our knowledge. This would clearly agree better with the desired possibility of such an *a priori* knowledge of objects that could establish something about them before they are presented. Our suggestion is similar to that of Copernicus in astronomy, who, finding it impossible to explain the movements of the heavenly bodies on the supposition that they turned round the spectator, tried whether he might not succeed better by supposing the spectator to revolve and the stars to remain at rest. Let us make a similar experiment in metaphysics with perception."

Kant's rather remarkable lack of appreciation of the work of his predecessors led him to emphasize unduly the novelty of his own point of view. Yet subsequent philosophers have tended quite generally to regard him as its most representative exponent. And he forced the issue with such energy as to make himself the most prominent figure in the philosophy of the last century. He asserted repeatedly that we do possess knowledge of objects which is universal and necessary, and he asserted with no less frequency that in all such cases our knowledge has not conformed to objects, but objects have conformed to the necessities of thought. Just because we find that we *must* think of objects in a certain way, we must admit that this necessity springs from thought itself. In spite of the fact that this assumption is far from self-evident, Kant succeeded in imposing it upon his time with remarkable success. The philosophy of the nineteenth century witnessed as a result many noteworthy attempts to determine what reality must be by reference to the necessities of thought alone. The absurdities of Schelling and the subtleties of Hegel mark, perhaps, the extremes of this tendency.

But the significance of Kant is not seen only in this new inspiration given to the attempt to determine, not what reality is, but what it *must* be. For his philosophy had its negative side, which contained an equally important emphasis. Just because what we must think is due to the necessities of thought, we have no right, he urged, to extend the results of such thinking beyond thought itself and so pass to things as they are. Exterior to thought, beyond its controlling influence, they escape us utterly. The significance of this important limitation Kant exhibited most crucially when he criticized all attempts of speculative thinking to establish the

existence of God, freedom and immortality, the three things with which, as he viewed it, metaphysics is most concerned. Here thought finds itself completely baffled and confronted by contradictory possibilities for which there appears equally valid evidence. him an able support, and Heine could say of the 'Kritik,' 'This book is the sword with which, in Germany, theism was decapitated.'

Kant, however, would find in practical life and particularly in moral life a way of transcending the limits



IMMANUEL KANT.

Thus metaphysics would appear to be an impossible science—a result in strange contrast with the successive systems of metaphysics which the positive aspect of his work called into being. Kant remained stubbornly true to his conviction that the necessities of thought set their own impassable limits. Agnosticism has thus found of speculative thinking. In his writings on morality and religion he claims that the necessities of practise have also a determining influence on the content of philosophy. Man's morality presupposes as conditions necessary to its existence the very things—God, freedom and immortality—which man's reason can not attain, and the existence

of morality itself becomes, therefore, the guarantee of their existence. Practise thus gives what speculation fails to give. So after all the theologian could take courage from the Kantian philosophy, and the pragmatism of to-day could find a basis in the searching criticism of the Königsberg professor.

The significance of Kant for modern philosophy has thus been wide and varied. He has been at once an inspiration and a check to free speculation, and also a source of renewed progress in moral and religious inquiry. Yet, it must be admitted that his importance has waned considerably in recent years. His central idea that there are necessities of thought and practise which of themselves significantly determine the content of our knowledge and belief has come to lack its authoritative tone. This has been brought about not so much by direct refutation as by the steady advance in stability of scientific knowledge, which insists that we can be really compelled only by the exigencies of the things with which we deal. Kant in his early years was no mean scientist. Indeed he thought that his philosophy could give to science its only stable basis and its only correct interpretation. The result is in striking contrast with his conviction.

RECENT PROGRESS IN THE STUDY OF RADIOACTIVITY.

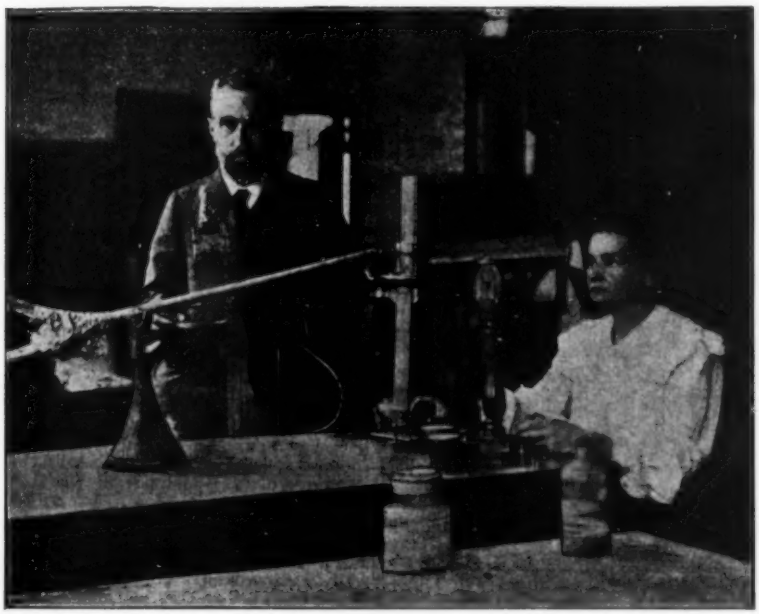
THE dream of the alchemists had without doubt a strong philosophical foundation, and although the desire to accomplish transmutations of the elements has lost all power as an incentive to the study of natural phenomena, one can not help noticing the small amount of reverence modern physics has for the identity of the atom of a chemical element. The electronic theory of matter, well set forth by Sir Oliver Lodge in his Romanes lecture at Oxford, which was published in this magazine last August, holds that there is no more difference between the atoms of the different elements than between houses of different shapes and sizes, but built of the same kind of bricks, the little electrons being the bricks of which the atoms are built, although the structure of an atom is more like that of a planetary system than that of a house. Confidence in the stability of this structure in the case of ordinary atoms has not been shown to be misplaced, but in the case of the radioactive substances—elements they are by the usual tests—evidence of atomic disintegration continues to accumulate. Their radiations consist chiefly of projected particles, far smaller than the atoms of the radioactive elements, and, as Professor Rutherford and Mr. Soddy have shown, the radioactive matter passes successively through a series of unstable forms. The final product of this atomic disintegration must be stable and therefore not radioactive, and since the gas helium is found in all radioactive minerals it is suggested that helium is one of the stable residues left by the heavy and unstable radioactive atoms.

During the past summer Professor Ramsay, the discoverer of terrestrial helium, and Mr. Soddy followed up this suggestion with experiments and came to the conclusion that helium is continuously produced by radium. The experiments consisted in examining in a spark tube the spectrum of the radioactive gas, or emanation, given on dissolving in water fifty milligrams of nearly pure radium bromide that had been in the solid state for some time. This radioactive gas is not stable, but decays in a geometrical progression with the time, the rate being about half in four days. Of course the most careful precautions were taken to free the spark tube from foreign gases, especially hydrogen, oxygen and carbon dioxide. When first prepared the tube gave a new and hitherto unknown spectrum, probably that of the radioactive gas. After four days the lines of the helium spectrum began to appear, growing brighter for several days, while the new spectrum observed at

first disappeared. The supposition is that the helium is the product of the atomic decomposition of the radioactive gas. It may be argued that the experiments only prove that radium is not an element, but only a compound of staple elements. On the other hand, the production of this radioactive gas is not influenced by changes of temperature, which is true of no chemical process, and is accompanied by radioactivity, which is not a phenomenon of chemical changes.

examined contained one eleven-hundredth as much radium as pitchblende, the ore from which radium is extracted. Radium salts are found to give off heat at a very considerable rate. M. Curie estimates that radium can melt its weight of ice in an hour. A more exact investigation by Rutherford and Barnes shows that the radioactive gas and the secondary activity are the chief sources of the heating effect.

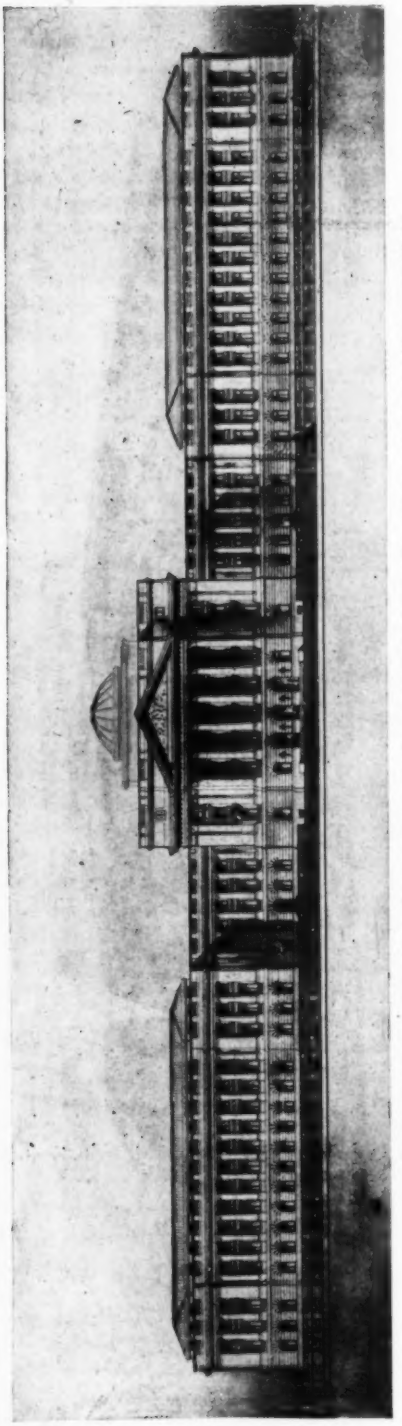
The treatment of certain diseases, particularly of cancer and lupus, by



M. AND MME. CURIE IN THEIR LABORATORY.

The wide distribution of radioactive matter has been brought to light by the work of Professors Elster and Geitel in Germany on the radioactivity of the atmosphere and soils, and by a number of observers under the leadership of Professor J. J. Thomson on the presence of a radioactive gas in many spring and well waters. Elster and Geitel discovered that clay is much more active than other soils, apparently from the presence of a trace of radium, though much depends on the locality. A certain clay which they

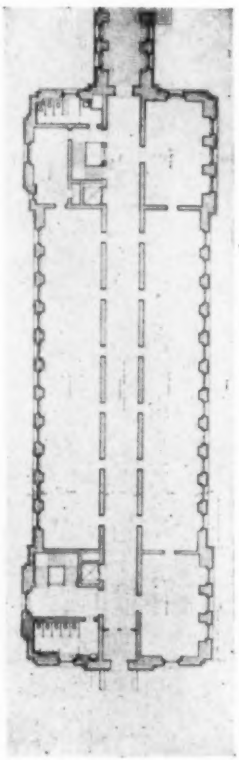
means of radium radiation continues to attract much attention from physicians both in this country and in Europe. A committee appointed by the Vienna Academy of Science to investigate the results of the treatment of cancer with radium reported that in nine cases in which the treatment was used abatement in the cancerous swelling resulted and in two of these cases the swelling had not reappeared after five months' time. A case of cancer of the palate was much improved by the treatment. The use of radium is



NEW BUILDING OF THE U. S. DEPARTMENT OF AGRICULTURE, SOUTH ELEVATION, FACING ON PROPOSED MALL.

not recommended when an operation is practicable. Numerous other cases of the beneficial results of the radium treatment have been reported in this country and England.

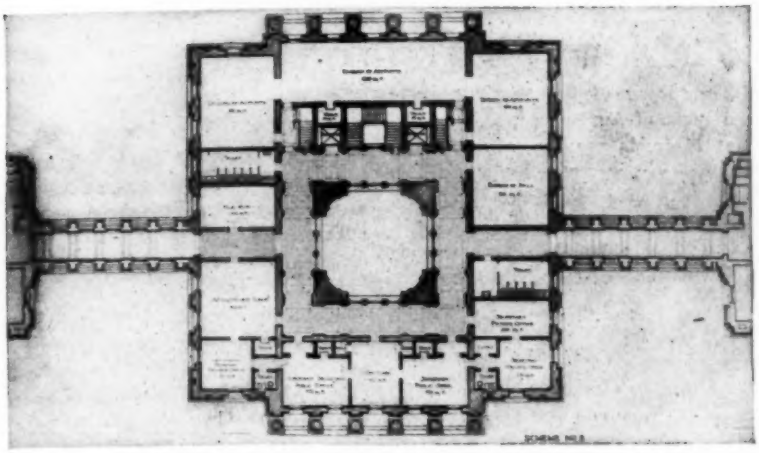
More exact measurements by other observers corroborate the conclusion of Rutherford that the radiations from radium which are the least penetrating of the three types present, but represent the greater part of the energy,



LABORATORIES, PLAN OF FIRST FLOOR.

consist of positively charged particles of about twice the mass of the hydrogen atom, and moving with a velocity about one tenth that of light.

The supply of radium on the market is very uncertain. All of it is imported from France or Germany, and the price has recently been going higher. Many efforts are being made to extract radium in this country from carnotite, an ore of uranium that is found in considerable abundance in Colorado and



ADMINISTRATION BUILDING. PLAN OF SECOND FLOOR.

Utah. These efforts have met with some degree of success, but radium from carnotite is not yet on the market.

NEW BUILDINGS FOR THE DEPARTMENT OF AGRICULTURE AT WASHINGTON.

The plans for the new buildings for the National Department of Agriculture contemplate a group of ten buildings, arranged in the form of a quadrangle, with an administration building as the central feature. The nine laboratory buildings will be units, and will be connected with the administration building by covered corridors. They will be 60 by 200 feet each in size and 4 stories in height above a high, well-lighted basement. The administration building will be about 135 by 160 feet and 5 stories high. The latter, with a laboratory building on either side, will present an imposing front of 700 feet, which will face south on the broad parkway planned to extend from the Capitol to the Washington Monument.

The appropriation of $1,500,000 made by congress will provide for the erection of three laboratory buildings, leaving the administration building and the others to be provided for later. As the new site is some distance removed from the site of the present buildings, the latter can remain in use in the meantime. The three new buildings will provide accommodations for the laboratories and offices of the department now occupying rented buildings, as was directed by congress.

The buildings will be classic in design and will probably be built of marble. The construction will be of the most substantial character, with thick walls carrying heating and ventilating flues. The interior space will be divided into units 20 by 20 feet, and each unit will have access to a conduit furnishing water, steam, gas, electricity, air pressure and exhaust. The actual arrangement of the laboratories has not yet been settled, nor has it been definitely decided which three of the laboratory buildings will be erected now.

The department is now occupying very inadequate and in many cases temporary quarters, and is paying an annual rental of about $25,000 for buildings located outside the department grounds. Its main building was long since condemned and is in no sense a modern structure. The staff of the department at the time it was erected included less than 100 persons; the present enrollment is about 4,200

persons. A group of buildings in keeping with the dignity and importance of agriculture in our national economy and significant of the service of the Department of Agriculture to the country at large, is greatly to be desired. A year from now congress will probably be asked to provide further funds, so that the administration building (estimated to cost $1,000,000) and possibly other laboratory buildings may be erected.

SCIENTIFIC ITEMS.

WE regret to announce the deaths of Dr. Charles Emerson Beecher, professor of historical geology at Yale University and a member of the governing board of the Sheffield Scientific School; of Dr. Emil Alexander de Schweinitz, chief of the Biochemic Division, U. S. Department of Agriculture; of Arthur William Palmer, D.Sc. (Harvard), head of the Department of Chemistry of the University of Illinois, and of Miss Anna Winlock, computer and assistant in the Harvard College Observatory.

DR. DAVID DUNCAN, having been entrusted by the late Mr. Herbert Spencer with the writing of his biography, will be obliged to persons who may possess letters from him of value if they will kindly lend them for the purpose of such biography. All letters addressed to Dr. D. Duncan, care of H. R. Tedder, Esq., secretary, the Athenæum, Pall-mall, London, S. W., will be carefully preserved and returned in due course to their owners. Mr. Spencer's autobiography will be published by Messrs. D. Appleton & Co., on March 25.

THE steamship *Princess Irene*, bringing the remains of James Smithson, arrived in New York on January 20. These were transferred to the *Dolphin* of the U. S. Navy and taken to Washington. They have been deposited in the Smithsonian Institution until arrangements can be made for suitable burial in the grounds of the institution and the erection of a monument. The remains were brought to this country by Dr. A. Graham Bell, at whose instance the regents arranged for the removal, owing to the fact that the English cemetery at Genoa in which Smithson was buried was to be abandoned.

AT the annual meeting of the Royal Astronomical Society on February 12, Ambassador Choate received the society's gold medal on behalf of Professor George E. Hale, of the Yerkes Observatory.—The Lalande prize in astronomy has been conferred upon Director W. W. Campbell, of the Lick Observatory, by the Paris Academy of Sciences.—The French minister of public instruction and fine arts has conferred the degree of officer of public instruction upon Dr. Lester F. Ward for his scientific and sociological works.